QUARTERLY JOURNAL OF METHODS AND INFORMATION FOR TEACHERS OF SCIENCE

UN 21 '51

The SCIENCE COUNSELOR

Volume XIV ★ Number 2 ★ June, 1951

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The Science Counselor

"FOR BETTER SCIENCE TEACHING"

A QUARTERLY JOURNAL *of teaching methods and scientific information especially for teachers of science in Catholic schools. Indexed in the Catholic Periodical Index. Published at Duquesne University, Pittsburgh, Pennsylvania, in March, June, September and December by*

THE DUQUESNE UNIVERSITY PRESS

Subscription Price: $2.00 per year; Canada, $2.25. Single copies of issues in the current year, 60¢ each.
Business and Editorial Offices at Duquesne University, 901 Vickroy Street, Pittsburgh 19, Pa.

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Volume XIV June, 1951 No. 2

CONTENTS

IN FUTURE NUMBERS 37
SOME FACTS ABOUT AMINO ACIDS 38
M. J. Blish
WARTIME CAMOUFLAGE 39
T. F. Cooke
FROM SEEDS OF GRASS TO THE STAFF OF LIFE 41
Alfred C. Andrews
NEW HORIZONS IN OXYGEN THERAPY 43
John B. Dunne
CHEMICAL WEED CONTROL 46
A. L. Bakke
THE HEAT PUMP—A GOLD MINE? 48
George E. Sutton
METEORITICS AND SPACE NAVIGATION 50
Lincoln LaPaz
RADIOISOTOPES IN BIOLOGY 52
R. H. Burris
FICTION AND FACT IN CRIMINALISTICS 54
Charles E. O'Hara
THE STOCKHOLM INTERNATIONAL BOTANICAL CONGRESS 56
Lydia Bourne Walsh
GUIDING SCIENCE STUDENTS 58
T. H. Dunkelberger
NEW BOOKS 60

In Future Numbers . . .

Among the articles planned for publication in the near future are:

Fertilizers for the Garden
By Joseph B. Edmond, Department of Horticulture, Mississippi State College, State College, Mississippi.

•

Bird Life in the American Tropics
By Alfred O. Gross, Department of Biology, Bowdoin College, Brunswick, Me.

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By Ivan T. Sanderson, National Speleological Society, New York City.

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Mushrooms, Edible and Poisonous
By Alexander H. Smith, The Herbarium, University of Michigan, Ann Arbor, Michigan.

The Modern Water Faucet
By Theophilus M. Schmid, Chlorination Specialists, Chicago, Illinois.

•

A Science Program for Service Clubs
By Robert E. Verseput, Science Department, Dover High School, Dover, N. J.

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Loran
By Fletcher G. Watson, Graduate School of Education, Harvard University, Cambridge, Mass.

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The Safe Use of Pesticides
By Bernard E. Conley, Committee on Pesticides, American Medical Association, Chicago, Ill.

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Some Facts About Comets
By Allan D. Maxwell, Department of Astronomy, Howard University, Washington, D. C.

Some Facts About Amino Acids

• By M. J. Blish, Ph.D., (*University of Minnesota*)
SUPERVISOR OF ORGANIC CHEMICAL RESEARCH, AMINO PRODUCTS DIVISION, INTERNATIONAL MINERALS & CHEMICAL CORPORATION, CHICAGO, ILLINOIS

This paper is an account of the occurrence, production, and uses of the amino acids that constitute the basic units of proteins.

Dr. Blish, a specialist in the field, shows how and why proteins vary in their properties and biological functions, why certain amino acids are "indispensable" to man, why wheat protein is low in nutritional value, and how protein hydrolysates may be used as food supplements. He includes numerous other interesting facts, and the latest information concerning the amino acid "building blocks" so important in nature.

●

Amino acids are of preeminent importance primarily because certain acids of this group are the basic units or "building blocks" of which proteins are constituted. Proteins, as is generally known, are essential components of all protoplasm, and in animals they are structural constituents of muscle, skin, hair, ligaments, blood and other body tissues. Also known to be proteins are the enzymes, which promote and regulate all metabolic processes that are associated with plant and animal life. As might be expected, the proteins exhibit an enormous range of variation in composition, as well as in appearance, in physical properties and in the extraordinary versatility of their biological functions. Primarily this variation is attributable to differences in amino acid makeup.

There are almost as many different individual amino acids found in proteins as there are letters in the alphabet, and they can be combined in innumerable ways just as the letters of the alphabet are combined to produce different words and combinations thereof. Most protein molecules are known to be built up of many thousand amino acid units.

For practical purposes we can consider that there are about twenty-two different amino acids making up most of the more familiarly known protein materials, such as cheese, lean meat and egg albumin. Each individual amino acid has a definite and known chemical structure of its own, and it is possible to relate certain of these distinctive structural features to specific and characteristic chemical and biological properties. Since the amino acids themselves vary widely in composition and in chemical behavior it is not surprising to find even greater variation among the proteins, since they represent combinations of the various amino acids in all conceivable arrangements and proportions.

Some slight progress has been made in efforts to correlate peculiarities of amino acid composition with specific properties and with biological functions of proteins. We know, for example, that certain groups of amino acids occur predominantly (while others are lacking) in those proteins which form various protective tissues such as hair, fingernails, wool, silk, etc. It is, however, among the *food* proteins that variations in amino acid content have been found to have implications of the most critical importance to human welfare. These implications are based upon two main considerations: (1) Of the twenty-one or twenty-two amino acids which are needed for the building and repair of body tissues and for supporting vital processes, ten cannot be synthesized in the animal (or human) organism, at least in quantities sufficient for normal health requirements, and these ten accordingly must be derived from the food intake. They have therefore been designated as the "indispensable" (or "essential") amino acids, in contrast to the others, which can be synthesized by the animal and are therefore characterized as the "dispensable" (or "nonessential") amino acids, since they do not have to be supplied from food sources. (2) Some food proteins, especially those of plants, are either lacking or deficient in certain of the indispensable amino acids, which means that those which are lacking must be supplied from other sources if health and efficiency are to be maintained.

The names of the indispensable and dispensable amino acids are shown in the following Table.

CLASSIFICATION OF AMINO ACIDS

Indispensable	*Dispensable*
Arginine	Alanine
Histidine	Aspartic Acid
Isoleucine	Citrulline
Leucine	Cystine
Lysine	Glutamic Acid
Methionine	Glycine
Phenylalanine	Hydroxyglutamic Acid
Threonine	Hydroxyproline
Tryptophane	Norleucine
Valine	Proline
	Serine
	Tyrosine

Proteins which supply all of the indispensable amino acids in suitable amounts and proportions are said to have high nutritional and/or biological values. Among these are the proteins of eggs, milk and meat. Instances of proteins which are lacking in one or more of the indispensable amino acids are found in wheat and corn, and in gelatin. Wheat protein, for example, is deficient in lysine content, and this deficiency alone is responsible for the fact that the biological value of the wheat protein is only about half that of milk protein. It has in fact been shown experimentally that the supplementation of wheat protein with a relatively small quantity of lysine will nearly double its nutritional value. The simplest and most practical method of avoiding a deficiency of any of the indispensable amino acids is to follow a diversified diet, which in-

(Continued on Page 70)

Wartime Camouflage

● **By T. F. Cooke, Ph.D.,** *(Yale University)*
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This article describes the principles on which wartime camouflage is based, and its use under combat conditions in the field and for protection of civilian installations.

Dr. Cooke, a Captain in the Army during World War II, was a member of the camouflage section, and later Director of the Materials Laboratory of the Engineer Board, the Research and Development Agency for the U. S. Army, Corps of Engineers. His wartime experiences provide him with an excellent background for writing this article.

Permission to publish this paper was granted by the Defense Department.

●

Camouflage is the science of concealment or imitation. Some of the most common examples of camouflage are illustrated in nature by animals, reptiles, insects and birds that have protective coloring which blends with the surrounding terrain. Specific examples are the zebra and rattlesnake, which have disruptive color patterns, and the grasshopper and snowy owl, which have solid colors that match their natural habitats. An historical example of camouflage is the famous wooden Trojan Horse, by means of which Greek soldiers gained access to the walled city of Troy by hiding in its hollow interior.

Camouflage is used by the Armed Services in time of warfare to conceal personnel, equipment, supplies and movements in the theatre of war from both ground and aerial observation. It is used to confuse the enemy on the whereabouts of troops with the proper placement of dummy or imitation equipment including artillery, tanks and planes. It is also used to disguise important civilian installations such as factories, utilities and transportation facilities to prevent their being bombed from the air.

The chief principle upon which most camouflage is based is the matching of the natural surroundings in color, shape and texture. Camouflage is, of course, easier to accomplish if the objects to be hidden are well dispersed. For example, it is much easier to hide a dozen men if they are well dispersed in a large open field than if they are bunched together at one spot in the field. It is also much easier to camouflage a number of well dispersed small buildings than one large building.

Color is of prime importance in camouflage. It is much easier, for example, to conceal a soldier against snow-covered ground if he is dressed in white, than if he is dressed in olive drab. Likewise, it is easier to hide a building in a wooded area if the building is colored with a disruptive pattern of green and black (green to match the trees and black to match the shadows) than if it is painted white.

Since most naturally occurring objects are not bounded by straight lines or arcs of circles, it is important in the concealment of objects for them to be irregularly shaped. For example, a soldier's head can be concealed better if the silhouette of the round, steel helmet is broken up by means of natural foliage placed in a net worn over the helmet. It is much easier to hide a road from aerial observation if the road is winding rather than straight. Matching the texture or degree of roughness of the surrounding terrain is also extremely important in camouflaging an object. A winding, concrete road, even though it is painted a color matching the surroundings, will be readily picked up by aerial observation because it does not have the texture of the terrain through which it passes. It will have a much more shiny appearance caused by its higher specular reflection than the adjacent grass, soil or trees. In order to reduce this specular reflection, objects which will make small shadows, such as sawdust, blocks of wood or granules, can be applied to a roadway with an asphalt adhesive. Such applications are very helpful in introducing shadows and thus increasing the texture of roadways so that they more nearly match the surrounding terrain.

A number of manufactured as well as naturally occurring materials, such as bushes, branches from trees and leaves, are used for camouflage purposes. One of the best and most commonly used materials for camouflaging combat equipment in the field is fish nets into which are woven narrow strips of colored osnaburg (loose weave cotton cloth) or burlap fabric. These nets

FIGURE 1. An artillery piece camouflaged with a fish net interwoven with colored fabric.

are usually supported above the equipment to be camouflaged by means of a set of metal or wooden stakes but are sometimes draped directly over the equipment. Figure 1 shows an artillery piece camouflaged with such a garnished fish net. These nets are comparatively light, durable and easy to carry in the field. They provide a disruptive pattern of different colors which can be modified to match the terrain. The holes in the fish net that are not filled with the colored burlap or osnaburg strips provide from the air and from distant ground observation the effect of shadows or texture.

The burlap and osnaburg strips are supplied in ten different colors as well as black and white. These colors were chosen to be representative of the entire range of colors occurring in nature. They were selected after a colorimetric study involving spectrophotometric curves of approximately 300 soils typical of those occurring throughout the world's surface, approximately 100 leaves both green and dried from tropical and temperate vegetation, and a large number of grasses.

For camouflaging fixed installations, chicken wire to which materials such as painted steel or glass wool are fastened is the most common netting used for concealment purposes. The reason for using steel and glass wool is to provide texture.

Some of the best materials for camouflage purposes are naturally occurring materials such as branches and leaves from trees, grass and straw. For field combat purposes, branches from trees oftentimes are festooned over vehicles and artillery pieces. The most important advantage of natural materials is that they can be obtained on the spot and do not involve transportation from a base of operations. Their biggest disadvantage, if the foliage is green, is the difficulty of maintaining the green color. Of course, if whole trees or bushes are used in their natural habitat this problem does not exist.

An emulsion paint which can be thinned with water at temperatures above freezing and with gasoline at temperatures below freezing is provided to the troops in the field for camouflage purposes. This paint gives a lusterless, flat finish and is supplied in the ten camouflage colors, plus black and white. It can be used in disruptive pattern painting of vehicles to match the terrain in which the troops are fighting. This paint can also be applied to the burlap and osnaburg garnished fish nets to change the color of the nets to match a specific terrain. In addition, it can be used to paint buildings, airplanes, artillery pieces, tanks, etc.

The Army provides combat soldiers with an olive drab uniform. This olive drab color was chosen not because it is a specific match for the color of any given terrain but because it is a fairly dark, neutral shade which is not conspicuous and provides fairly good camouflage in most terrains. For a snow terrain, of course, white is desired to match the color of the snow. A uniform was developed in World War II and used fairly extensively by the Marine and the Army personnel in the Pacific which has a disruptive pattern much like that of a leopard, but having dark green and black spots. This disruptive pattern provides excellent camouflage against a tree or bush background for the green spots are a very good imitation of green leaves and the black spots appear like shadows.

To complete the camouflaging of the troops in the field, face paints in various colors are supplied to change the color of a man's face to blend with that of the surrounding terrain. In the coloring of the face, a disruptive pattern is considered best. Materials available in the field, such as wet soil, ashes, charcoal, etc., can be used similarly for coloring the face.

Dummies or imitation equipment were oftentimes used in World War II. Replicas of tanks, artillery pieces, airplanes, etc., were prepared which were amazingly realistic in their appearance; their purpose was to confuse the enemy as to the whereabouts of troops and equipment in the field. These dummies are made of materials such as wood, metal, paper and rubber-coated fabrics which can be inflated by air.

Smoke used to hide troop movements in the field, ships at sea and amphibious operations, especially troop landings, is an important camouflage material. Very effective smoke generators utilizing the partial combustion of petroleum products have been developed which produce sufficient volumes of smoke to cover large areas rapidly.

Airplanes can be fairly well camouflaged with paints. The underside of the airplane should be painted white and the upperside a darker color, preferably with a disruptive pattern. For nighttime fighting, planes may be painted black. Examples of airplanes camouflaged with paints were common in

(Continued on Page 66)

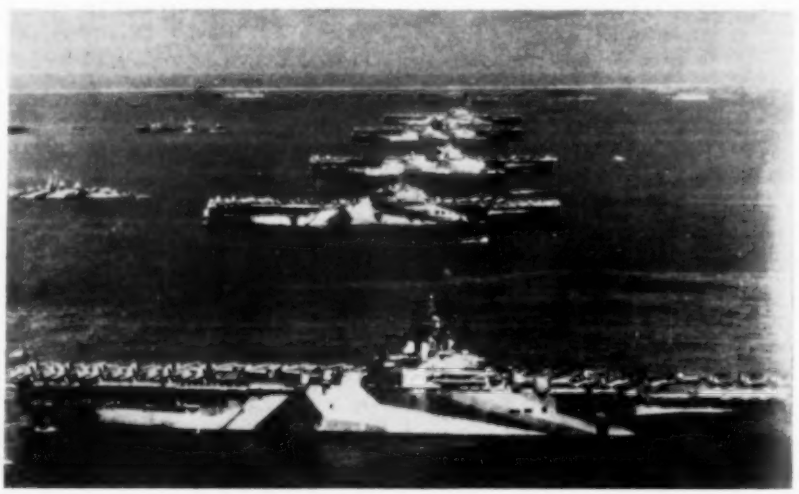

FIGURE 2. A dazzle pattern of black, white and gray reduces the apparent size of the ship and confuses the observer as to the direction in which it is traveling.

From Seeds of Grass to the Staff of Life

● By **Alfred C. Andrews, Ph.D.,** *(University of Pennsylvania)*
ASSOCIATE PROFESSOR OF CLASSICS, UNIVERSITY OF MIAMI, MIAMI, FLORIDA

This is an article of unusual interest.

Did you ever wonder how common wheat came to be the grain from which our daily bread is made?

The story is long and involved. It is told here briefly in the simple readable style that not all specialists have been able to master as well as has the distinguished writer of this paper.

●

In various parts of the world today the seeds of grasses are gathered and used for making bread. In some regions certain of these grasses are cultivated, but they are still essentially wild plants, little changed from the form in which they were known to early man.

To single out one area, in the Mediterranean region the seeds of couch grass are sporadically collected and used with bran for making cakes and bread. Buckwheat is raised here and there in mountainous sections, and wild buckwheat is similarly used as a cereal, but less commonly. The farinaceous seeds of manna grass, which are tasty, agreeable and nutritious, until fairly recent times were frequently gathered in northeastern Germany, Hungary, Russia, and Poland. They were rough-ground, and used in a mush with milk or butter. The seeds of spurry have occasionally been used for making bread, as have those of marsh bedstraw. Tufted eragrostis produces edible seeds that are sometimes used for making bread; and its cultivated form, which differs in only minor respects from the parent form, is one of the most important food plants of Ethiopia. Canary grass is raised in some Mediterranean lands today for its seeds, which are not only used as feed for canaries, but also mixed with wheat flour to make bread and cakes.

The cereal plants which today contribute so largely to the world's food supply are all basically grasses, and most of them have passed through a long evolutionary process. Wheat, the most important of them all, is also the one which has the most complicated family tree and has undergone the most radical changes. In the Old Stone Age man knew these cereal plants only as wild grasses, the seeds of which formed part of his daily fare. They were neither particularly better nor worse than those of other grasses, such as those mentioned above. They attained their present prominence, not so much because of superior palatability and food value, but because they could be raised and their products processed into food for man with less labor than the others.

Many cereal plants have fallen by the wayside because they could not meet this competition. The same sort of ruthless competition has eliminated from the commercial field many vegetables once in common use. The tassel-hyacinth was under intensive cultivation in both Greece and Italy in the classical period, but today the bulbs of the wild plants are gathered only by peasants for household consumption or sale at a local market. The seeds of the Indian lotus, the white lotus, and the blue lotus were much used in ancient Egypt for making bread; but they were gradually supplanted by the cereals. Sea-kale was cultivated by the Romans, later fell into disuse, then in the eighteenth century was introduced into England from Italy and soon became a popular garden potherb; but today it is almost unknown as a commercial vegetable. Similarly, Alexanders were much cultivated as a garden vegetable in Italy in the classical period, lapsed from use, enjoyed a vogue in England in the sixteenth century, and then disappeared from gardens. Wherever we turn, we find the same picture of economic competition among the food plants, with the occasional elimination of some notable for their superior savor and food value.

We Americans are inclined to think of our diet as richly varied and to boast that we are the best fed people in the world. It is true that we are very well nourished; but our dietary habits, coupled with the cost of food production, limit the range of our diet to a far greater degree than we generally realize. The average American is apt to consider no dinner complete without bread and potatoes, and whether he dines out or eats at home, he is likely to confine his choice of other vegetables to a few of the most common ones, such as peas, carrots, onions, beets, and cabbage. As a matter of fact, when he dines out, the usual menu does not give him much choice. Rarely would he find listed such items as leeks, chives, skirrets, taros, elecampane, chervil, mallows, or orpine.

This brings out a curious paradox that is worldwide in its application, namely, that with progress in civilization there is a substantial decrease in the variety of foods regularly consumed by ordinary people. The reason for this becomes clear when we reflect that in remote prehistoric times the range of palatability and nutritive value among various available foods was comparatively small and that normally none was found in abundance.

Early man was a food gatherer, and as such was forced to exploit the alimentary potentialities of his environment to the full and to utilize everything that could be eaten. But as the use of cultivated plants and domestic animals increased, involving on the one hand greater palatability and food value, and on the other greater economy of effort, much more food being produced with the same expenditure of energy, there was a steady trend in the direction of a limited number of basic foods. An important contributing factor was the development of efficient means of distribution, en-

couraging the production of food in excess of the needs of the immediate family.

In the early stage of the Old Stone Age in Europe, man, as a food gatherer, subsisted on wild fruits, tubers, roots, nuts, berries, leaves, and the seeds of herbaceous plants, in addition to such animals as were easy prey. Even larvae, worms, snails, and insects presumably contributed to his diet, as well as shellfish and such other aquatic life as came easily to his hand. Man was then nomadic, did not polish stone or flint, had no knowledge of pottery, practiced no agriculture, and raised no domestic animals. Later, in the Pleistocene Age, he became primarily a hunter, and the chase formed the core of his daily activity. In that epoch Europe teemed with animals, and it was easy to obtain fresh meat whenever he was hungry.

In the middle stage of the Old Stone Age man continued to be primarily a hunter, but changes in the fauna resulting from modification of the climate forced him both to improve his weapons and tools and to specialize in his hunting.

In the concluding stage of the Old Stone Age the chase continued to be important; but game was gradually becoming scarcer. For this reason the men of the family were forced to devote more time and energy to hunting, and the task of gathering wild plant products gravitated more and more to the women.

With the disappearance from Europe of the large mammals toward the end of the Old Stone Age, fish and other aquatic food took on greater importance, although the chase was still preeminent. These more strenuous pursuits continued to preempt the time and energies of the men. Meanwhile, the women had begun to transplant the bulbs and roots of wild plants and to sow the seeds of wild cereals near their homes, thus creating private gardens. At first they used only crude digging sticks to till the ground, later hoes. In the New Stone Age there was a great forward sweep, for in that epoch man finally ceased to be the servant and became the master of his food supply through the development of domestic animals and the active cultivation of plants, by the fashioning of improved tools and the use of cooperative labor.

The chase as a primary source of meat waned as domestic animals acquired ever greater importance to man's diet, and the care of flocks and herds absorbed the attention of the men as exclusively as had hunting before. Hoe agriculture, formerly sporadic, now became the normal method of cultivation, and was carried on chiefly by the women. Man's food supply, previously collected at random and immediately consumed, now lost its haphazard character, for he was assured of adequate provisions throughout the year.

As man emerged from the New Stone Age, hunting continued to wane and agriculture to grow in importance, particularly as plow agriculture with draught animals gradually displaced hoe agriculture; and as the Iron Age developed, the range of cultivated plants steadily increased, with cereals in time coming to play a dominant role.

This is the broad picture; but it is noteworthy that as man emerged from the New Stone Age, he stood at a fork in the road of civilized progress. He had domestic animals and a crude form of agriculture. If he gave his attention primarily to his domestic animals, he continued to be nomadic, for he had to go where there was feed for them. But if he devoted himself more to agriculture, he became sedentary, developed a community life, and lost his nomadic character.

On the whole, the choice was not his to make. The branch of the fork along which he traveled was largely determined by the conditions existing in the area where he lived. The climate and the soil had to be favorable to agriculture to encourage him to stress this aspect of food production. But this was not enough, for the soil had to be easy to till. If it was thickly forested or covered with a thick mat of grass that defied his crude tools, the easier course was to raise domestic animals. It is therefore not surprising that it was in the fertile valley of the Nile and on the alluvial plains of Mesopotamia that systematic agriculture began. Furthermore, since irrigation was required in both areas, and since the land could not well be irrigated piecemeal, there was a powerful incentive to cooperative effort. This led to the evolution of city states with centralized control, for only thus could the potentialities of the land be realized.

It was accordingly in Egypt and Mesopotamia that the grains were first taken under systematic and intensive cultivation. From the beginning and for many thousands of years wheat and barley predominated in these regions. But the wheat that was raised there was very different from the type usually used for making bread today. Our bread is almost universally made from one or another of the so-called true wheats. These are free-threshing or naked wheats, as opposed to the "spelt" or hulled wheats. The latter have the common characteristic of having invested seeds which when ripe are firmly enclosed in the glumes, so that a special operation before milling is necessary to free the grain from the chaff. There are three main species of hulled wheat — one-grained wheat or einkorn, two-grained wheat or emmer, and spelt.

One-grained wheat, one of the most primitive of the cereals, apparently originated in Asia Minor as a development from the wild parent form and spread by the northern route in prehistoric times through central Europe to France and Spain. It was cultivated in varying degrees, sometimes intensively, in widely scattered areas around the Mediterranean in the New Stone Age and the Bronze Age, but not in Italy, continental Greece, or Egypt. It was later supplanted by better wheats and today is raised only here and there in mountain districts.

Two-grained wheat, also a primitive cereal, evolved from a wild parent form at the eastern end of the Mediterranean and was taken under cultivation very early. It was this wheat which, along with barley, was singled out for particular attention in Egypt and Mesopotamia, perhaps as long ago as 10,000 or even

(Continued on Page 68)

New Horizons in Oxygen Therapy

● By **John B. Dunne, B.S.**, *(New York University)*
PROFESSIONAL SERVICES REPRESENTATIVE, MINE SAFETY APPLIANCES COMPANY, PITTSBURGH, PENNSYLVANIA

Here are new facts for the teacher of chemistry, the teacher of biology, and even for the athletic coach. This paper contains important news for the general reader as well.

The oxygen tent in the sickroom is no longer a last resort, to be used when all else has failed. Oxygen can be used to prevent and to relieve in a number of situations.

This up-to-the-minute information will interest every science teacher and every science class.

●

In the past decade we have become so engrossed in the wonders of drug therapy as exemplified by the antibiotics that we have neglected to note the steady march forward of an old technique—oxygen therapy. Once regarded as a treatment of desperation, oxygen administration is now regarded as therapeutic, prophylactic and palliative. Once prescribed as "a heroic measure" in pulmonary disorders, the use of oxygen is now routine. Can't you remember the hushed stillness which used to mark the announcement "They've got him in an oxygen tent"? Now, thanks to new reliance on oxygen as a very necessary part of the regimen of the treatment of many illnesses the patient gets this helpful treatment just as naturally as he gets penicillin.

Why has the use of oxygen been so limited in the past? Why has it been resorted to only when the patient had respiratory difficulties or became cyanotic? The cost was one factor. Oxygen cost a lot of money. This was due in no small part to inefficient methods of dispensing the gas, methods which wasted more than went to the patient. A second reason may have been the lack of understanding of what oxygen could do for the patient, and a vague feeling that it might be toxic.

New methods of dispensing oxygen that were developed during World War II have brought about great efficiency in the administration of the gas. Also larger use of oxygen by hospitals has forced the basic price down, and the producers have been able to effect greater efficiencies in its distribution. As for the toxicity of oxygen, studies during World War II showed that 100 per cent concentrations of oxygen could be breathed continuously for periods up to 24 hours with no deleterious effects. These reasons and others militate in favor of the expanded use of oxygen in human disease. Actually we are now at the threshold of a new realization of how great a weapon this gas can be in prolonging life and in combatting the effects of faulty oxygenation.

In thinking of new horizons for this type of therapy, let us first consider some of the diseases or disorders that logically can be treated with oxygen. Space will not permit a very complete treatment of these, but such a list may pique the imagination of the reader and other uses may become obvious.

Pneumonia: Naturally, when we think of oxygen therapy we immediately think of its use in pneumonia. The patient suffering from this disease is often working up hill because the areas normally concerned with transport of oxygen to the arterial blood are full of fluid or purulent mucus. The effective area of the lungs is thus impaired. When the blood is not properly oxygenated, the whole organism suffers. Furthermore, if the patient is forced to labor to get his breath, he may create sufficient intrapulmonary suction to increase the fluids in his lungs, thus worsening his condition. If oxygen can be given to him early and throughout his period of illness, his respiratory efforts will be kept at a minimum and his blood oxygen levels will be kept high, forestalling anemia and other debililating effects. Another distinctly favorable result of oxygen therapy will be lessening the load on the patient's heart. This organ is forced to work overtime when the oxygen saturation in the blood is lowered. Conversely, when oxygen

OFFICE AND HOME treatment of many disorders is now possible with new simple and economical regulating devices.

is available in good supply, the heart rate is slowed down preventing fatigue of this vital organ.

Reference was made to the "early" institution of oxygen therapy measures. Let us re-emphasize that this technique should be employed just as soon as possible to procure the best results—not as a last resort when the patient is already in great difficulty.

Cardiac Cases: Of all the muscles in the body the heart muscle can least well withstand oxygen want. So great are the requirements of this organ for oxygen that even denying an adequate supply for a matter of seconds may cause a severe heart spasm. If this basic fact is recognized, we can see the extreme importance of making oxygen available to the heart patient. In coronary heart disease especially, oxygen therapy is urgently needed. Furthermore, the oxygen should be so readily available to the patient that little or no inspiratory effort is required of him to get it. Even in the cases of angina pectoris anginal pains can be alleviated by the prompt breathing of oxygen by the sufferer.

The chronic cardiac patient probably should have oxygen available in his home. The means for dispensing this should be simple, safe and efficient so that no delay will be experienced if an emergency arises. We shall discuss the dispensing equipment a little later in this paper.

Migraine Headaches: The use of oxygen in the treatment of migraine offers interesting possibilities. Drs. W. C. Alvarez and Chas. E. Rhein reported on the use of this gas in a paper which appeared in *Proceedings of the Staff Meetings of the Mayo Clinic*, March 15, 1939.

AN INTERMITTENT positive pressure instrument is used in the treatment of many pulmonary disorders.

Migraine sufferers often have an aura before the onset of the pain in the head. That is to say there is a warning period which signifies a headache is about to ensue. If the patient can lie down and promptly breathe oxygen it is often possible to abort the headache, or at the very least lessen its intensity. Why oxygen therapy is effective in such cases is not entirely understood. A suggested solution is that oxygen disposes the blood to the alkaline side. Carbon dioxide has the opposite effect. Breathing oxygen may tip the balance in favor of the alkalinity of the blood, thus averting the headache which is often associated with acidity. Our acid-base relationship is maintained in a fine balance and the above solution may be valid in view of this fact.

Be that as it may, the physician with the migraine patient who is particularly resistant to drug therapy should certainly explore the possibilities of oxygen therapy. The patient can be provided with simple equipment in the home or office for safe administration when he experiences an aura of the onset of a headache.

Asthma and Bronchial Disorders: No other field of oxygen administration holds so much promise for the relief of sufferers as in cases of asthma, silicosis, chronic bronchitis and allied diseases. The work done by Drs. Hurley L. Motley and Burgess Gordon at Jefferson Medical College Hospitals has thrown new light on the efficacy of the use of oxygen under intermittent positive pressure in conjunction with aerosols, and has given new hope to the silicotic, the asthmatic and those with like ailments. Earlier, Dr. Alvan Barach described the use of oxygen as a means of transporting aerosolized medication into the patient's bronchial tree and lungs.

The asthmatic and silicotic have two basic symptoms in common, collapsed bronchioles and dyspnea or shortness of breath. The treatment introduced by Drs. Motley and Gordon consists of using oxygen therapy equipment capable of delivering varying intermittent positive pressures and potent broncho-dilator drugs which have been aerosolized by a nebulizer. The drug is introduced into a mask or mouthpiece by the nebulizer, and the positive pressure picks it up and distributes it to even the terminal bronchioles, thus enhancing the value of the broncho-dilator. If a secondary infection is present, Penicillin, Streptomycin, Aureomycin and other antibiotics can be employed similarly.

Most patients receiving this treatment find subjective relief of shortness of breath. They often report a more productive cough and subsequent improved drainage.

Later investigations by Dr. Gordon and Dr. Motley are concerned with the use of non-toxic wetting agents used as described above. These are directed toward breaking up plugs and collections of viscous mucus. Success in this endeavor points to aid for the sufferer from chronic bronchitis, pneumonia and bronchiectasis.

Employment of Oxygen in Athletics: Up to this point we have concerned ourselves with the use of oxygen for patients. Now we should like to say a word about the use of oxygen for the robust and well person, in this case the athlete.

OXYGEN ADMINISTERED to athletes from portable units helps to offset fatigue and return breathing to normal. Japanese Olympic swimmers first exploited the use of oxygen and won most of the swimming events.

Widespread use of oxygen for athletics was first noted when the Japanese Olympic swimming team dealt such a blow to our national pride by sweeping almost all swimming events in the Olympic Games. In addition to having developed some excellent swimmers, the Japanese exploited the use of oxygen both before and after competition to offset the fatigue racing swimming will produce. The cry immediately was raised that they were "souping up" their swimmers. Nothing could have been further from the truth.

It must be realized that in athletics as in any other form of extreme exertion we create an "oxygen debt." Just like money borrowed from the bank, this must be repaid. It can be repaid slowly by rapid, labored breathing of air, or it can be repaid quickly by breathing oxygen for a short period of time. In the latter case the heart, pulse and respiratory rate are returned to normal in one-third less time. Thus instead of "souping up" the athlete, oxygen therapy *quiets him down* and relieves the load on his heart that much quicker. This is especially beneficial to the high school athlete whose body has grown much faster than his heart. Please don't mistake us, we did not say oxygen removed the tired feeling from the athlete's muscles. This is due to lactic acid build-up which will be eliminated only after complete rest for a protracted period. Oxygen helps chiefly to quiet the heaving chest of the athlete and remove the load from his heart.

Equipment: As an outgrowth of World War II the demand-type oxygen therapy regulator now makes extremely simple the administration of oxygen in the hospital, physician's office, ambulance, or home or in athletics. These regulators were developed for the use of airmen flying at high altitudes. They allow oxygen to pass only when the person inhales. His exhalation shuts off the valve, thus conserving the gas. In order to put such equipment into operation one needs only to place the regulator on a cylinder, turn on the cylinder valve, and the patient does the rest. There is no more effort required than breathing in the outside air.

Intermittent positive pressure apparatus was mentioned previously. This equipment was also an outgrowth of work done by the Air Force. The Aero Medical Laboratory at Wright Patterson Air Force Base was responsible for the development of the Burns and Bennett Valves. These are now available commercially, and are in use by Dr. Motley and Dr. Gordon and many other medical men employing this life saving technique.

Conclusion: At the outset we indicated that the technique of oxygen therapy has made great strides, but its progress has been overshadowed by other very dramatic advances in treatment of human disease. It is altogether possible that research and clinical investigation now going on will focus more attention on the benefits of this type of therapy. In any event, the doctors who are employing oxygen to its fullest extent and value are creating new horizons in the control and prevention of human disease. ●

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New England Meeting

The thirteenth Summer Conference of the New England Association of Chemistry Teachers will be held August 20-25th in the new science buildings at Rhode Island State College, Kingston, R. I. Anyone who has ever attended one of these meetings knows what a treat is in store for those able to come this year. Some 15 speakers will participate in the program. There will be a symposium on the teaching of chemistry, especially emphasizing science in general education. There will be a workshop on pupil participation in chemical demonstrations as a classroom project. W. George Parks of the Rhode Island State College will act as host.

Chemical Weed Control

• By **A. L. Bakke, Ph.D.,** *(University of Chicago)*
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This paper tells how you may lighten the labor of gardening, and how you may keep your lawn dandelion-free. It tells how agriculturalists and others kill unwanted growth on a large scale.

Time, effort and expense are saved by the intelligent use of herbicides. Certain compounds, when properly applied, destroy weeds or prevent their growth, leaving the crop plant unharmed.

Dr. Bakke discusses 2,4-D, 2,4,5-T, TCA, Ammate, Sinox, sodium chlorate, and other compounds that have been found effective.

●

The control of weeds by the use of chemicals is not a new project.

In 1908, Professor Bolley of the North Dakota Agricultural Experiment Station reported the results of 12 years of experimentation in the eradication of weeds in which he used common salt, iron sulfate, copper sulfate and sodium arsenite. He made this statement: "When the farming public has accepted this method of attacking weeds as a regular farm operation, the gain to the country at large will be much greater in monetary consideration than that which has been afforded by any other single piece of investigation applied to field work in agriculture."

During this period from 1896-1910, considerable interest in the eradication of weeds by chemicals was present, but after that, there was a lag. With the advent of 2,4-dichlorophenoxyacetic (2,4-D) in 1944, there has resulted a new vitalized interest in weed control. Practically every experiment station in the United States now has a project on weed control. Commercial concerns since 1944 have developed scores of chemicals which may have value as herbicides. In the United States there are four regional weed control conferences which meet once a year. A movement is on hand to form a national organization and to publish a journal.

A rather active interest in the use of chemicals for weed eradication was maintained in Europe. Rabaté of France showed that sulfuric acid at a concentration of 6 to 10 per cent killed annual weeds in grain fields without appreciable injury to the grain. Korsmo in Norway found that broad-leaved weeds growing in spring seeded grain were killed wtih sulfuric acid with an increase of more than 25 per cent in ripe grain over the unsprayed. Sulfuric acid is still used rather extensively in the weeding of onions.

There was considerable demand particularly by railroads for a chemical weed killer. Sodium arsenite had become the standard weed killer of commerce. On account of the poisonous properties of arsenic compounds, there were many hazards connected with their use, particularly to live stock. About 1927 Åslander of Sweden working at Cornell University demonstrated that sodium chlorate could be used to eradicate Canada thistle. Lathshaw and Zahnley of Kansas showed that this material was effective in killing European bindweed. To this day sodium chlorate remains the most effective chemical for the eradication of many perennial weeds. The amount necessary for the eradication of Canada thistle and European bindweed is about 5 pounds per square rod. Even at that, the annual consumption of sodium chlorate before the war was 12,000,000 pounds.

The main objection to the use of sodium chlorate outside the cost is the fire hazard. When sodium chlorate is mixed with organic material and later dried, it is dangerous to handle. Many accidents resulted. One chemical company manufactures a product "Atlacide" which contains materials which materially reduce the fire hazard. There have also been attempts to fortify sodium chlorate by the addition of other ingredients so as to reduce the cost. When sodium chlorate is used in sufficient quantity to destroy perennial weeds, the ground generally becomes sterile for a year or more afterwards, depending upon the environmental factors present.

Ammonium sulfamate, known commercially as "Ammate" is another herbicide. Although rather recently discovered, it has proven to be effective in controlling such perennial weeds as poison ivy and leafy spurge. This material is not toxic to animals nor is it a fire hazard. It has given

WEEDS CHOKE the corn where a herbicide has not been used

good results in the killing of tree stumps and in the elimination of sprouts. Large quantities of Ammate have been used in controlling brush growth under power transmission lines.

In 1937, "Sinox," sodium dinitroorthocresylate, was introduced into the United States from France. It is an acid, orange-colored dye made from the by-products of the distillation of coal. Sinox has been used in California for the control of annual weeds. At the present time, a similar compound, ammonium dinitroorthosecondarybutylphenol has largely replaced the earlier Sinox. The dinitro compounds have been extensively used in controlling annual weeds in peas, flax and small grain where legume seedlings are present.

A CORN FIELD that has been sprayed with 2,4-D.

In California and other states, oils have been extensively used as herbicides. Due to differences in physical and chemical properties, and due to differences in resistance to oils by certain plants, oils in many cases can be advantageously used. One of the best examples is in the growing of carrots. The so-called Stoddard solvent, a naphtha type of oil is not toxic to the members of the carrot family but is toxic to most weeds associated with carrot growing. As a result the grower can spray carrots with 50-80 gallons of oil per acre without injury to the carrots. In that case much of the expensive hand weeding is eliminated.

Up to the time of the Second World War, arsenic compounds, sulfuric acid, sodium chlorate, ammate, dinitro compounds, and oils were the more common chemical compounds used in the control of weeds. Salt, borax and carbon disulphide were also employed to a limited extent. In general the cost was too high. Considerable attention, of course, was given to cultural practices such as fallowing, special cropping, mowing before seed formation, and the use of competitive crops. Although the importance of weed eradication had been realized, the situation apparently was becoming worse rather than better. The concept that weeds were simply an index of poor farming was not holding the place it once did.

In 1944, 2,4-dichlorophenoxyacetic acid (2,4-D) was added to the list of herbicides and has proven to be remarkably effective. When refined, it is a white powder with no offensive odor; it is not caustic nor does it have any corrosive action. It is non-toxic to animals. It can be used as a water spray. Being of a hormone or growth regulator type, it does not occupy the same position in the chemical make-up of the plant as the mineral elements or carbohydrates. In minute amounts, the growth regulator substances produce characteristic effects on growth such as curvature of stems and abnormal formative developments in the foliage. In 1945, the American Chemical Paint Company obtained a patent for the synthetic production of 2,4-D. Within a year production was measured in thousands of pounds and the price dropped in two years from $125.00 to less than $3.00 a pound. The commercial value of 2,4-D is now measured in millions of dollars. Since the amount used is exceedingly small, 2,4-D is the cheapest herbicide available at the present time.

The material when added to the plant leaf is absorbed quickly, and after it has made its way through the palisade layer and the spongy parenchyma layer, is moved in the phloem along with the manufactured food material. The action is particularly pronounced in the parts undergoing active growth. Respiration is increased and the starch reserves are depleted. The chemical is selective in that grasses generally are not affected. It is then possible to spray a blue grass lawn with 2,4-D and have the dandelions and plantains eliminated. The war department has recognized that 2,4-D may be an effective weapon in biological warfare.

The pure form of 2,4-D is practically insoluble in water. It is then necessary to combine it with other substances so that it can be used for the purpose intended. Three different types of formulations have been evolved: (1) sodium salt (powder form); (2) amine[1], a liquid; (3) ester[2], also a liquid. The active action is based on the amount of the 2,4-D acid present. The esters are faster acting and are less liable to be washed away after rains. At the same time they are volatile and must be used with extreme care so that sensitive crop plants are not killed.

Where these growth promoting chemicals are used as herbicides, it is necessary to use the right amount. If you use too small an amount you may not kill the weeds, but if you use too much, you will injure the crop. In the case of flax, ⅛ pound per acre of an ester formulation is sufficient; in spring-planted small grain, ¼ pound per acre can be used. The important factor is the amount of the 2,4-D acid, and it matters little whether you use the specified amount in 100 gallons of water per acre or 10 gallons per acre. In using the low gallonage the operator does not have to haul around a large amount of water. In airplane spraying, the low gallonage application is still more vital than where ground equipment is used.

(Continued on Page 66)

[1] Amines are compounds which are derived from ammonia by the replacement of hydrogen by one or more univalent hydrocarbon radicals.
[2] Alcohols combine with acids to form esters.

The Heat Pump -- A Gold Mine?

● By George E. Sutton
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The heat capacity of the earth is great. It is available everywhere and always. Why not use the earth's heat to warm your house in winter and cool it in summer?

It can be done, but a number of problems must be solved before it can be done economically. Some of them are described in this paper.

"The heat pump may be a gold mine but mining costs are high."

●

One of the most illusory developments in the air conditioning field in recent years is the heat pump. To define, a heat pump is any device which will move heat from a low temperature locality to a high temperature locality. A refrigeration unit is such a device. In air conditioning, the term heat pump symbolizes a system which will furnish winter heating as well as summer cooling. In summer, the heat is drawn from the conditioned space by the evaporator or cooler, and deposited outside the space by the condenser. In winter heating this process is simply reversed, the evaporator being on the outside, and the condenser on the inside.

A schematic diagram of such a system is shown in Figure 1. The valves marked "S" are open for cooling, those marked "W" are closed. Conversely, for heating, the valves marked "W" are open, and those marked "S" are closed. In this manner, when valves marked "S" are open, the flow follows arrows marked "S". The source coil then acts as condenser, the air or other source absorbing the heat of condensation. The cooled refrigerant is then expanded in the expansion valve marked "S", and absorbs heat from air passed through the conditioning coil.

When valves marked "W" are open, the flow is as shown by arrows marked "W". The conditioning coil is now the condenser giving up the heat of condensation to the air passed over it, thus adding heat to the conditioned space. The condensed refrigerant is then expanded in the expansion valve marked "W" and absorbs heat from the source coil.

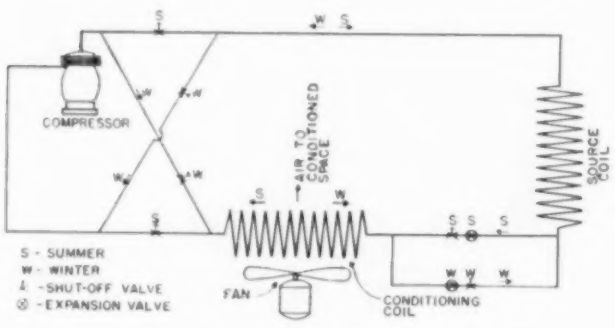

FIGURE 1. Schematic Piping Diagram for a Heat Pump.

To illustrate the attractiveness of the heat pump, some basic principles of refrigeration are required. A useful term applied to refrigeration is "coefficient of performance," designated COP. It is the ratio of refrigeration to the work required to achieve this refrigeration.

In theory the COP for air conditioning should be about seven; however, in actual practice a COP of four is very good. Even with a COP of four, the heat pump is attractive, since, for one unit of work, four units of cooling or five units of heat are available.

Air has been a popular medium, primarily because of its abundance. Certain inherent difficulties arise, however. When heating is required, the atmosphere is cold, and when cooling is required it is hot. This severely reduces the efficiency of a refrigeration system, since the COP is decreased by lowering evaporating temperatures or raising condensing temperatures.

Water has been successfully used but it is not generally available in sufficient quantities at low cost.

The earth, however, is universally available, and consequently, has been considered as an ideal medium for use with the heat pump. The use of ground coils with some circulating fluid, either the refrigerant or some auxiliary fluid, is the usual means of utilizing the capacity of the earth.

The heat capacity of the earth is great. A cylinder of earth two feet in diameter and one foot long would give up 75 BTU in being cooled ten degrees Fahrenheit, or absorb a similar amount in being heated ten degrees. Since it is not possible to isolate such a section, heat would flow to or from the surrounding soil and add to the heat capacity.

At the University of Florida a test installation was made using a ground coil. The ground coil consisted of two 1½ inch pipe headers placed 40 feet apart connected by ten ⅝ inch brass tubes placed 24 inches on centers. The coil was placed 12 inches deep, shallow as compared to usual installations, in the hope of recovering some of the incident solar energy.

This solar energy impinges upon the earth at a rate of 1000 to 1200 BTU per square foot per day during the heating season. If this solar energy alone could be recovered, a plot of earth ten feet long by five feet wide would heat the average Florida home comfortably.

In the installation at the University of Florida, cold water was circulated during winter to test heat absorption, and hot water was circulated during summer to test heat dissipation. Water flow, water temperatures,

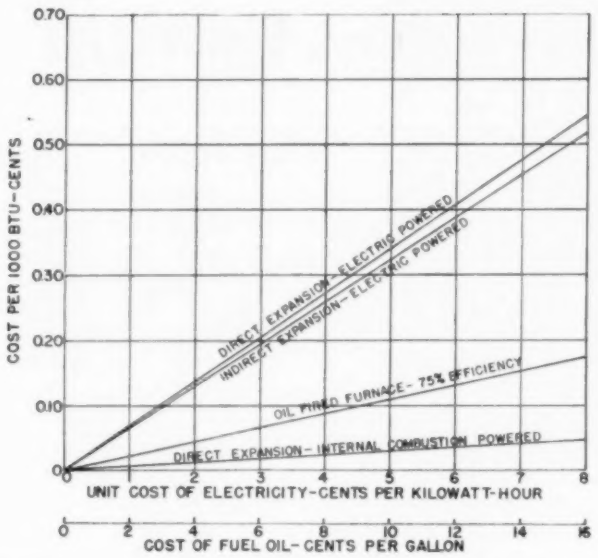

FIGURE 2. Comparison of Heating Costs of Direct Expansion Refrigeration Equipment (Reverse Cycle) and Oil Fired Furnace.

various soil temperatures, and atmospheric temperatures were measured.

Heat flow is dependent upon three factors: area, temperature difference, and conductivity, or ability to conduct heat. In radial flow, as in the case of a pipe buried in the earth, the area increases outward from the pipe as a function of the distance. Flow would be more difficult for a given amount of heat near the pipe than at a distance.

The temperature difference is important, since it governs the temperature of the circulated medium. As previously stated, it is desired to hold the temperature of the medium as high as possible when using the coil as an evaporator and as low as possible when using it as a condenser. Florida is particularly fortunate in having a mild climate. Soil temperatures are consequently not extreme.

Conductivity is the major limiting factor. Soil conductivities are generally very low. Copper has a conductivity of 220 BTU per hour per square foot per degree F. per foot of thickness. The conductivity of soil, from dry soils to wet soils, varies from 0.1 to 2.5 BTU per hour per square foot per degree F. per foot of thickness. Cork, a very good insulator, has a conductivity of 0.025 BTU per hour per square foot per degree F. per foot of thickness. It would appear, then, that the earth was well on the way toward being a good insulator, or at least, a very poor conductor of heat.

Poor conductivity adversely affects the temperature difference between the circulating medium and the surrounding soil, decreasing the effectiveness of the coil. As heat is withdrawn from the soil immediately surrounding the coil the temperature begins to fall, resulting in a flow from the soil further outward giving heat to the cooler soil. Due to poor conductivity, there is insufficient flow, and the temperatures of the soil around the coil become very low before equilibrium is reached, i.e. before the flow and temperatures become steady.

A time lag between atmospheric temperature changes and corresponding changes at a depth of one foot was noted. This time lag was about eight hours, which was helpful to operation since the lowest earth temperatures, with corresponding low heat flows, would occur simultaneously with high atmospheric temperatures, and low heat demand. Even so, the results were not encouraging.

Intermittent operation, i.e. operating only part of a day, usually off during the late morning and early afternoon, similar to intermediate season operation was tested. Results were somewhat better than with steady operation, since the earth made some heat recovery during the off period, and consequently the temperatures surrounding the coil remained higher than with continuous heat withdrawal.

The average conductivity of the sandy soil (dry) was 0.36 BTU per hour per square foot per degree F. per foot of thickness. Moisture was added to the plot of earth by spray in an attempt to increase this low conductivity. An increase of 50 per cent was achieved by adding ⅛ gallon of water per square foot of earth per hour. Economics of the water addition show it not to be practical unless water is available at very low cost. If this were the case, the water would better serve as a heat source than the earth.

Since water was the circulated medium, sub-freezing temperatures were not possible. If sub-freezing temperatures were used, the effect of temperature difference would be supplemented by the latent heat of fusion of any moisture present. Moisture migrates naturally toward the lowest temperature. This should result in somewhat better operation as referred to the coil, but

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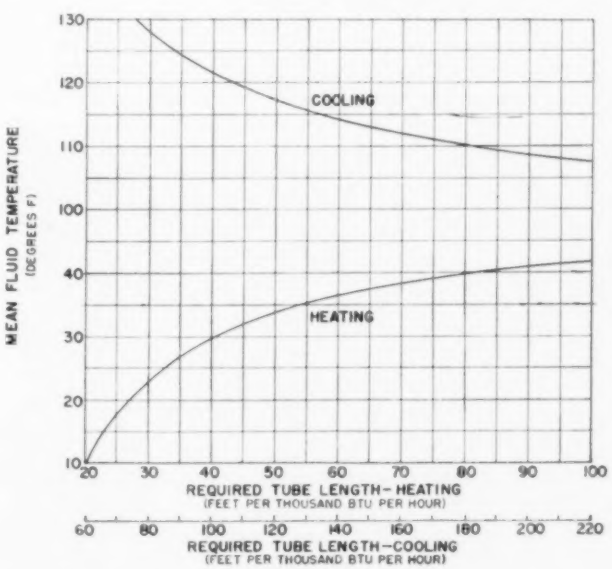

FIGURE 3. Approximate Tubing Requirements for Various Average Circulating Fluid Tempertaures.

Meteoritics and Space Navigation

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At this moment you may not know the difference between a meteor and a meteorite. This interesting article illustrates the difference by stating aptly that meteors may be likened to "luminous shavings produced when meteorites pass through the atmospheric planing mill."

Reading it may stimulate you actually to search for meteorites, an activity in which the non-professional can make discoveries of genuine scientific value.

The Institute of Meteoritics of the University of New Mexico will be interested in your finds. It will test portions of likely discoveries free of charge, and when found of interest may act to acquire them for the Institute. The Institute in turn supplies specimens gratis to scientific investigators.

●

In the remote days of Zeus and Company, the unexplored portion of the universe began just beyond the outstretched finger tips of the champion high jumper leaping upward from the peak of Mount Olympus. In this upper region the clouds formed, the beautiful arch of the rainbow appeared, the aurora shook out its magnificent draperies, and the meteor traced its evanescent but splendid path. This region, where the moon ran through its phases, and the sun, the fixed stars, and the restless planets had their abode, was for the Greeks the *unknown*. Naturally, they had a name for it—the *ether*.

Today, the world over, interest centers on the exploration of the ether of the Greeks. Already a certain infinitesimal portion of it is familiar to us. The airplane flies above the rainbow, the balloon rises above the highest clouds, and the rockets achieve transient trespass into the domain of the aurora and the meteor. This is but a beginning. Men are no longer satisfied with such brief and unsatisfactory high jumps into the unknown. Their present wish is to navigate space as they now sail the seven seas. Moderns have a name for such space-navigation. They call it *etheronautics*, and its students, *etheronauts*.

For varied reasons, scientists in many fields have long studied attentively the meteors that flame through and the meteorites that fall from the heavens above; but theirs is a pale academic concern in comparison with the anxiety of the etheronauts to learn all that *meteoritics*, the science of meteors and meteorites, can teach, convinced, as many prospective space navigators now are, that the advent of atomic power presages man's imminent liberation from his gravitational bondage, if not from the heavier burden of his own belligerent spirit. Those old timers who can remember back to the days when the motorist heading into the unknown West questioned drivers returning from what was then a bourne of highway hazard and mystery, will best appreciate why etheronauts bent on escaping outward from the earth scrutinize so closely the nature and behavior of bodies falling swiftly inward upon it.

Much is known about these bodies and the phenomena they give rise to either during their swift flight through the earth's atmosphere or at impact with our globe. In the first place, it should be pointed out that the common term for meteor, namely, "shooting star" is a flagrant misnomer and belongs to that era so well depicted in the *Fugger News-Letters* when every appearance of a fireball in the sky was regarded as a portent of disaster. A shooting star is by no means a distant sun in incredibly rapid motion; but rather appears when a swiftly moving cosmic particle is heated by the resistance of our own atmosphere to such a temperature as to become self-luminous. This abbreviated statement gives but little insight into the complexity of the meteor-producing process. It now seems well established that there are at least two stages in this process: a first, and generally invisible *low density* stage in which the air molecules strike directly upon the bare surface of the solid cosmic particle—"like drops of rain spattering on an astrodome." Such direct impacts occurring at velocities of 10 to 50 or more miles per second speedily volatilize the outer layer of the solid particle and the vapor thus generated forms a sheathing "instantaneous microatmosphere" about the ablating cosmic particle which greatly increases its *effective* size. In the next or *high density* stage, lower down in the atmosphere, the innumerable collisions between this complex of solid, liquid, and gaseous matter and the obstructing air molecules transform the kinetic

FIGURE 1. THE FURNAS COUNTY, NEBRASKA, achondrite at the bottom of its impact hole.

FIGURE 2. REMOVAL of the meteorite.

energy of the swiftly moving complex into other energy forms—notably ionization, heat, and radiation. A portion of the radiation thus developed is in the visible part of the spectrum and, consequently, the complex finally becomes visible to the naked eye and merits the name *meteor*. The solid mass, evaporation of which is responsible for the luminous phenomenon of a meteor, is called a *meteorite*. In view of the kinetic energy carried by even the tiniest such solid mass moving in the velocity range indicated above, it is clear why the etheronaut is so concerned in regard to the probability of collisions between space ships and meteorites; the damage resulting from such collisions; and, last but not least, the effect on his communications of meteoritic static (analogous to the precipitation static hated by all aviators).

On most nights, even under the matchlessly clear skies of the Southwest, the average number of meteors seen per hour will not exceed 10 or 15, although 20 or more may be seen in the hours after midnight. However, on certain nights in *each* year, as in the case of the perennial August meteors called Perseids because they seem to radiate from the constellation of Perseus; or on certain nights in *certain* years, as in the case of the Nu-Draconids, which were seen in such profusion on the night of October 9 in 1933 and in 1946, the hourly rate may increase so greatly as to give rise to what is justly called a "shower" of meteors. Such showers are among the most spectacular of all natural phenomena, and their beauty and scientific interest well explain the eagerness with which the *expected* return of the Nu-Draconid meteors in October, 1952 and/or October, 1953 is awaited.

The reader familiar with the accuracy of eclipse-predictions may look askance at the qualifying term "expected" used above in connection with prediction of a meteor shower. However, proper appreciation of the handicap under which the meteor observer works will certainly dispel any tendency to make "invidious comparisons." On the one hand, eclipse calculations are made on the basis of the countless accurate measurements of the position of the moon in the sky, which for generations have been carried out with every possible refinement. On the other hand, the particles producing meteors are not visible at all until they are actually evaporating in their final swift dash through the atmosphere. Since the great majority of meteors are too faint to be photographed, give no warning of their infall to the visual observer, and are visible on the average less than half a second, it is clear that the numerical data available to the theorist in the field of meteoric astronomy does not begin to compare in accuracy with that utilized in making eclipse predictions. Furthermore, the meteoriticist's problem is greatly complicated by the differential perturbations which the massive planets exert on the widely separated members of a swarm of meteorites which are but feebly held together by the weak self-gravitation of the group.

A second inference can be drawn from the short duration of the average meteor and the high rate of meteoritic ablation thereby implied; namely, that unless the extra-atmospheric mass of the invading meteorite is considerable, there is little possibility that any of it will survive the shrinkage incident to its transit through the atmosphere and fall to the surface of the earth as a solid mass. The meteors are luminous shavings produced when meteorites pass through the atmospheric planing mill. Like milled planks, the solid meteorites emerge from this experience much reduced in size. If they are quite small to begin with—as are most of the meteorites in interplanetary space—then nothing tangible endures to fall from the atmosphere upon the earth.

In fact, on the average, not more than a thousand or so of the hundreds of billions of meteorites that annually encounter the earth's atmosphere, actually drop solid survivors on the land surface of our globe. These survivors vary from almost invisible dust-like particles to the extremely rare macro-meteorites, packing more punch than the atomic bomb, which by their explosive penetration into the earth-target blow out "meteorite craters," ranging in diameter from a few feet to several thousands, or possibly tens of thousands.

(Continued on Page 62)

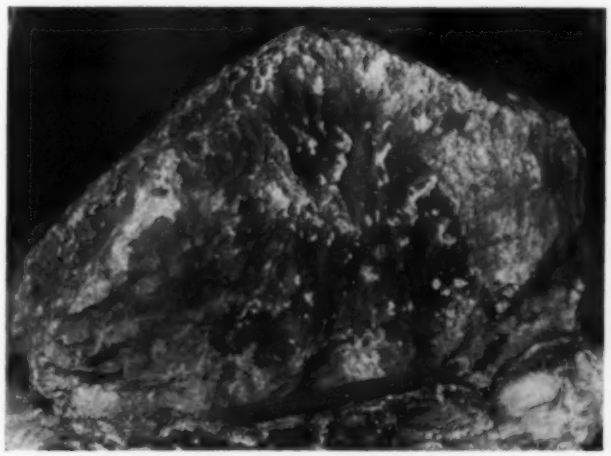

FIGURE 3. THE FOOT-RULE gives some indication of the size of the meteorite.

Radioisotopes in Biology

• By R. H. Burris, Ph.D., *(University of Wisconsin)*
DEPARTMENT OF BIOCHEMISTRY, UNIVERSITY OF WISCONSIN, MADISON, WISCONSIN

Although radioisotopes are a new tool in biological research, they have already made possible a considerable number of fundamental discoveries. They are treated by organisms like the corresponding inactive isotopes, they serve as specific labels, and they can be detected in extreme dilution.

Tracer technique has been used to determine the distribution of iodine in man, to devise optimum methods for the application of phosphorus-containing agricultural fertilizers, to study photosynthesis, and in a number of other ways that are reported or suggested in this brief but highly informative article.

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It is difficult to overemphasize the importance of radioisotopes in current biological research. They constitute a tool comparable in importance to the microscope. Whereas the microscope permits the biologist to examine physical structures of subvisible size, the isotopes allow him accurately to determine chemical events within the cell.

As early as 1913, Hevesy realized the possibilities of radioisotopes as tracers. At that time he used radiolead to determine the solubilities of lead chromate and lead sulfide. In 1923 he made the first application of radioisotopes to a biological problem, when he followed the absorption and translocation of radiolead in plants.

Hevesy's early work necessarily was confined to the few naturally occurring radioisotopes, but this limitation on the tracer method was removed by the discovery of artificially induced radioactivity by Joliot and Curie in 1934. This discovery was followed quickly by the production of a great variety of radioisotopes in cyclotrons and other particle accelerators. Numerous applications of these isotopes were made to problems of plant and animal physiology, but widespread use was still restricted by the necessity for the maintenance of costly particle accelerators for the production of radioisotopes.

Uranium nuclear reactors, developed during the war, furnish an extremely high intensity source of neutrons. After the termination of the war, the Atomic Energy Commission assigned a nuclear reactor at Oak Ridge to the production of radioisotopes for research uses. Here suitable materials are placed in small aluminum cans and irradiated with neutrons in the nuclear reactor. These materials, now rendered radioactive by the neutron bombardment, are shipped to users in the original aluminum cans, or processed to isolate specific elements before shipping. Radioisotopes are supplied for a nominal charge to competent investigators who have received an allocation from the Atomic Energy Commission. This ready availability of radioisotopes has resulted in their widespread use, and has greatly accelerated progress in many types of biological research.

As the tracer technique is relatively new and extremely potent, it has been surrounded with an aura of glamour, difficulty and infallibility. It now is being more generally recognized in its proper perspective as a perfectly straightforward, readily usable technique of wide, but not universal, applicability. The tracer method consists of labeling a compound with an isotope, administering the labeled compound to the biological system, isolating products from the system, determining their radioactivity, and interpreting the biological reactions from the analytical results. A few examples should serve to illustrate in a limited way the usefulness of radioisotopes in biological research.

To determine the distribution of iodine in the animal body by usual techniques is a difficult task. However, if a small amount of radioiodine is administered to an animal, it can be followed qualitatively by exploring the intact animal body with a shielded Geiger counter tube. If more nearly quantitative results are desired, the animal may be sacrificed and its isolated organs analyzed for radioiodine. By either technique one will observe a spectacular concentration of iodine in the thyroid gland.

Concentration of radioiodine in the thyroid serves as the basis for the use of the isotope in thyroid therapy. Certain types of hyperthyroidism can be cured painlessly by the simple process of giving the patient a few carefully chosen and well timed doses of radioiodine in orange juice. Apparently the radioiodine localizes in the thyroid and there destroys the excess thyroid tissue; the gland thus is brought into proper balance with the other organs of the body.

Another isotope that has been used very extensively by biologists is radiophosphorus. Phosphorus is a constituent of many biologically important compounds. The role of phosphorylated compounds in energy storage and transport is particularly intriguing to the biologist. As the phosphorylated compounds often occur in low concentrations, the great sensitivity of the isotope method is welcome in following their fate.

An isolated example of carbon dioxide fixation by a heterotrophic bacterial species was reported by Wood and Werkman before isotopes of carbon were available. The report was greeted with skepticism, for it fostered an unconventional idea; heterotrophs by definition were not supposed to use carbon dioxide. However, when isotopic carbon became obtainable, not only was the carbon dioxide fixation reported by Wood and Werkman readily confirmed, but the phenomenon also was proved to be widespread in nature. The isotopic tech-

nique is so much more sensitive than the methods available earlier, that it has revealed carbon dioxide fixation in almost every tissue tested. This has changed a basic concept of heterotrophism.

Although the use of isotopes with animals may have most general appeal, isotopes have been equally useful to the biologist studying plants and microorganisms. Much information on the mechanism of microbial fermentation reactions has been uncovered with isotopes. With green plants the isotopes have been applied to studies of such diverse problems as ion absorption and transport, transport of growth regulators, photosynthesis, heterotrophic fixation of carbon dioxide, formation and distribution of plant viruses, and soil fertility.

In pre-isotope days statements appeared in textbooks of plant physiology to the effect that uptake of ions by plants was a rather rapid process and could be demonstrated in as little as two hours. When isotopes were used to test the speed of ion uptake by single celled plants, it was possible to demonstrate substantial accumulation of ions in as little as 15 seconds. These dramatic results necessitated a reinterpretation of the mechanisms of ion uptake.

After radioisotopes are absorbed, their transport in the plant can be determined by placing a shielded Geiger counter tube next to particular leaf and stem sections of the intact plant. With many plants, radiophosphorus added to the nutrient solution around the plant roots can be detected in the leaves within a few minutes.

Certain plant growth substances have received wide acceptance as weed-killers. However, the manner in which they kill plants remains unknown. The fundamental problems of where they go in the plant from the point of application has been answered by treating plants with a growth substance labeled with radioiodine. It is apparent that the substance moves to all parts of the plant. Information on another pertinent question, how long does the growth substance administered remain intact in the plant?, has been obtained by using a growth substance labeled with radiocarbon. Recovery of the labeled compound established its rate of degradation in the plant.

Our agricultural economy has become more and more dependent upon the application of fertilizers, but it has been impossible to determine whether a plant derives its mineral nutrients from those initially present in the soil or from those added in the fertilizer. Isotopes allow one to resolve this problem. An extensive cooperative project, under sponsorship of the U. S. Department of Agriculture, has been undertaken in several states to determine the optimum methods for administering phosphorus as a fertilizer element. Various formulations of phosphate fertilizers containing radiophosphorus are supplied to the investigators, who test a variety of methods for applying them in the field. An analysis of total phosphorus and radiophosphorus in the plant material harvested permits calculation of how much of the phosphorus of the plant came from added fertilizer and how much from that normally present in the soil. This constitutes another example of solution with isotopes of a problem virtually insoluble otherwise.

Photosynthesis is the most important process on earth. We are dependent upon it for our food, fiber, and most of our usable energy. Photosynthesis has been studied widely, but the manner in which the green plant captures the sun's energy, reduces carbon dioxide, and liberates oxygen remains largely undetermined. Tests with the rare stable isotope of oxygen have proved the source of photosynthetic oxygen to be water rather than carbon dioxide. The segment of photosynthesis dealing with carbon dioxide fixation and reduction has been clarified greatly by use of radiocarbon.

Calvin and coworkers supplied carbon dioxide containing radiocarbon to suspensions of single-celled plants. After as little as 5 seconds exposure to the isotope, the cells were killed with hot alcohol; already they had formed several compounds from the labeled carbon dioxide. The compounds extracted from the cells were separated by paper chromatography. The paper chromatograms then were placed in contact with X-ray film for a few days. In areas of the chromatogram where radioactive compounds were present, the radiations exposed the photographic film. When the film was developed, black spots appeared at the positions of the radioactive compounds on the paper. Such tests showed that upon very short exposure to labeled carbon dioxide, the plants accumulated most of the isotope in phosphoglyceric acid. Phosphoglyceric acid is now accepted as a key compound in photosynthesis.

These few examples perhaps give some idea of the scope of application of radioisotopes to biological problems. The facts that radioisotopes are treated by the organism like the normal inactive isotope, that they can be detected in tremendous dilution, and that they serve as specific labels has made them one of the most valuable tools of the biologist. In many cases they permit the solution of problems which defy solution by other means. ●

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"Nevertheless, examination of basic objectives suggests certain directions in which these courses should be strengthened or modified. To me, such an examination leads to the conclusions that careful, rigorous teaching of elementary facts and principles should not be slighted; that science must be presented as a great intellectual adventure in its proper historical perspective, rather than as isolated blocks of knowledge; and that the capabilities and limitations of science with respect to other activities of the modern world should be repeatedly emphasized. In these ways we take advantage of the teachability of science, we give it the necessary imaginative and intellectual content to justify a place in the general-education program, and we insure ourselves against the potentially dangerous consequences of too little knowledge."

—KONRAD B. KRAUSKOPF
The Journal of Higher Education

Fiction and Fact in Criminalistics

● By **Charles E. O'Hara, M.S.,** *(St. Peters College)*
CO-AUTHOR, "AN INTRODUCTION TO CRIMINALISTICS," BY O'HARA AND OSTERBURG, NEW YORK CITY

Scientific crime detectives and their amazing exploits are well known to every detective story devotee. But fact and fiction do not always agree.

It is true, however, that the police laboratory, using trained personnel, the latest methods, and the most modern apparatus has become a highly important tool in modern criminology.

This paper is from the pen of a well known worker in the field. He is co-author of O'Hara and Osterburg's "An Introduction to Criminalistics" (Macmillan).

●

Of the many industries which the first half of this century has fostered, fictionalized crime detection is in many ways one of the most interesting. It is, for one thing, a fifty-million dollar business. Approximately one-third of our movies, one-tenth of our radio shows, and one-fourth of story writing are devoted to detective mysteries. Upwards of a hundred murders are committed and tidily solved each week on the television screen. During the year 1949 forty-three million "Whodunits" were sold in pocket-book editions.

On the surface, America appears to be a nation passionately devoted to scientific crime detection. The heroes best known to the public are detectives, e.g., Sherlock Holmes, Charlie Chan, Nero Wolfe and Dick Tracy. A considerable number of our citizens are police buffs, detective hobbyists or members of esoteric detective societies (viz., The Baker Street Irregulars and The Speckled Band Club, which include in their membership such luminaries as Christopher Morley and Norbert Wiener). Another large segment of the population systematically employs police literature as an analgesic or soporific. Touching this last, what eminent figure does not at some point in his life explain to the reporters: "Reading? . . . After a hard day's work I usually relax in bed by reading a detective story."

Ordinarily it would be safe to assume that the real-life counterpart of this fantastic fictional image would be of sizable dimensions and reasonably solid substance. Since, moreover, the fictional detective is constantly resorting to scientific methods of crime detection, we should expect that these techniques are practiced on a somewhat comparable scale in actual life. Sherlock Holmes plunged boldly into the quantitative analysis of cigar ashes. The movie D.A. never hesitates to call in the "Lab." man for a paraffin test to determine the hand that fired the gun. The fictional F.B.I. agent has a Ballistics man within hailing distance to compare fatal and test bullets. Even the incomparable Dick Tracy carries on his person a blood-testing kit for field work. There is indeed extraordinary scientific activity in the offices of the never-never land operatives.

Newspaper men and writers in general assume that scientific crime detection is a well established field, peopled by many able practitioners and subsidized generously by public and private funds. The educated public believes that scientific criminology is in a fairly advanced state under enlightened leadership. They feel that it has a tradition, a literature and an extended development. The widespread currency of these impressions is understandable in the absence of any popular treatment of the factual history or the present state of criminalistics.

The existence of police laboratories in this country is a tribute to the anonymous struggles of a handful of hardy souls who persisted in their endeavors despite the absence of any active public support. As recently as 1921 the techniques of firearms identification were so little known that the bullet testimony of the Sacco-Vanzetti case bogged down in a muddle of conflicting expert opinions. The year 1930 may be said to mark the establishment of the first large scale police laboratory in this country. In the wake of the Wickersham Commission reports the Scientific Crime Detection Laboratory of Chicago was set up in affiliation with Northwestern University. Since that time, thirty or more police laboratories have been established mainly through the efforts of individual police departments. This number becomes less impressive when we consider that approximately one-third of the states do not possess police laboratories. Moreover, most of the cities with a population in excess of 100,000 are without facilities for scientific crime detection.

Of the existing crime laboratories few are equipped to the satisfaction of their directors. The inadequacy of the funds upon which these directors have had to rely emphasizes the significance of their achievements. Naturally, in a number of large cities such as Chicago and New York it has been relatively simple to establish a well equipped laboratory. In many other large cities, however, the police departments have been considerably less fortunate in their financial affairs and have had to struggle along with decidedly substandard facilities. Often the detectives have had to purchase their own equipment for such elementary procedures as fingerprint development. The police departments of these cities are by no means responsible for the poverty of their scientific resources. They have consistently agitated for the financial assistance that would make possible serious laboratory work. The absence of public interest, however, as reflected in budgetary provisions, has placed severe limitations on their aspirations.

(Continued on Page 72)

THE ELECTRIC WAVE SPECTRUM IN POLICE SCIENCE*

REGION	WAVE LENGTH (cm.)	SOURCE	APPLICATION
GAMMA RAYS ELECTRON RAYS	10^{-10} 10^{-9} 10^{-8}	SPONTANEOUS EMISSION BY RADIOACTIVE ATOMS	Investigative techniques for the detection of larceny and other crimes, using radioactive indicators to prelabel clue materials and a Geiger counter to detect radiations of the indicators Gammagraphs—Deep penetration to detect hidden structural flaws in metal Determination of the thickness of metals and depth of liquids in closed tanks by Penetron measurements
X-RAYS	10^{-7} 10^{-6}	ORBIT SHIFTS OF INNER SHELL ELECTRONS BY CATHODE RAY BOMBARDMENT	Electron microscopy of traces such as metals, dust, fibers, ink, semen, etc. Electron diffraction studies of surface film Analysis by x-ray diffraction to identify and compare substances Radiography to examine internal structure as in suspected bombs and defective metal parts—Examination for hidden contraband such as guns—Identification of unknown dead—Fogging of film in spy cameras—Detecting fraudulent paintings—Soft x-ray examination and comparison of clue materials such as fabrics, paper, leather, jewelry, biological specimens, and gunshot powder marks
ULTRAVIOLET	10^{-5}	VIBRATION OF INTERMEDIATE ELECTRONS	Detecting prelabeled gasoline, ink, money, documents, etc. Fluorescent examination of seminal and other stains, glass, gems, teeth, fingernails, hair, cosmetics, secret writing, erasures and obliterations, altered seals, laundry marks, fingerprints, pottery, statues, paintings Spectroscopy and ultramicroscopy
VISIBLE	10^{-4}	VIBRATION OF VALENCE ELECTRONS	Visual examinations as of fingerprints, handwriting, documents, photography, microscopy, spectroscopy, refractometry, spectrophotometry, colorimetry
INFRA-RED	10^{-3} 10^{-2}	VIBRATION OF ATOMS AND MOLECULES	Photographic comparison of textiles, paints, stains, inks, etc. Deciphering of burned and charred documents, erasures, invisible inks—Examination of the contents of sealed letters Thermometry—Spectrometry—Comparison of clue materials by molecular spectra Supersensitive bolometer for detection at night of persons in open spaces Snooperscope for observations in darkness Communication devices for secret messages Photocell intrusion alarm Infra-red camera for photography in darkness
MICRO WAVES	10^{-1} 1	SHORT OSCILLATIONS HIGH FREQUENCY DISCHARGE	Radar detection devices and direction finders Microwave receivers for detecting a beam reflected by an intruder Metal spotter employing loop antenna and receiver for detecting guns, wrenches, etc.
SHORT ELECTRIC	10 10^{2}	ELECTRONIC TUBES	Speed meter clocking motorists by reflected microwaves Analysis by electromagnetic induction Television—Rapid transmission of pictures of persons wanted or missing Mass spectrograph for the analysis of liquids and their vapors in arson cases
RADIO SHORT WAVES STANDARD BROADCASTING	10^{3} 10^{4}	SPARK-GAP DISCHARGE ANTENNA OR LOOP OSCILLATORS	Radio patrol cars—Marine patrol Field communication Walkie-Talkie Direction finders for locating source of secret broadcasts made for unlawful purposes Metal spotter operated by a cathode ray oscilloscope detecting reluctance changes Burglar alarm activated by a capacitance change in a grid circuit Lie detector Detectaphone for listening to conversations Missing persons alarm
LONG ELECTRIC	10^{5}	CIRCUITS HAVING LARGE CAPACITIES AND INDUCTANCE ALTERNATING CURRENTS	Traffic control by aerial survey and public broadcasts Control of floods, riots, and other disasters by radio warning Electromagnetic apparatus for retrieving guns, knives, and other metal objects submerged or otherwise inaccessible Magnetometer detection device for locating metal objects Detection of carbon monoxide by thermoelectric effects Teletype communication Comparison of clue materials by their electrical properties Testing of electrical equipment in cases of arson and electrocution Furnace temperature determinations with a pyrometer in cases of destruction of criminal evidence

* From *An Introduction to Criminalistics*, by Charles E. O'Hara and James W. Osterburg, 1949, by The Macmillan Company.

The Stockholm International Botanical Congress

● By Lydia Bourne Walsh
PROFESSOR OF BOTANY, ELMIRA COLLEGE, ELMIRA, NEW YORK

That attending a World Congress is a stimulating adventure is shown on every page of Miss Walsh's account of her experiences at the Botanical Congress that was held in Stockholm in July, 1950.

Published formal "Proceedings" are likely to be dull affairs. Not so this personal account of colorful incidents and happenings. You will enjoy reading it.

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It is the custom for scientists in those countries where free speech is practised to meet and talk freely about scientific matters. Often, they would be more comfortable at home. Sometimes it is even more profitable to remain at home and to read the published reports of the meetings later. I attended the VIIth International Botanical Congress—as a private individual; not as a representative of a group or institution. In reporting as a private person, I can tell you some aspects of the Congress that are not likely to be included in the published proceedings.

About 1250 botanists from 50 countries participated in this International Congress that had been planned by Swedish botanists. The wives of the Swedish botanists organized entertainment for the families of the visiting scientists. Thus while the Swedish and foreign scientists were discussing polyploidy, plant disease losses, or gene mutations, their wives and children were sightseeing and drinking coffee.

STUDENTS of Uppsala University sing in honor of the late King Gustav. Linnaeus, professor of botany at the University, is buried in the Cathedral shown in background. *Courtesy American Swedish News Exchange, Inc.*

At the opening session of the Congress the President, Dr. Skottsberg, professor emeritus of the University of Uppsala, gave the presidential address. He referred to the postponement of this Congress, originally planned for 1940, by World War II. As he named the nations that were represented at the Congress, the President said that no botanists were expected from Russia although they had been invited. However, almost at the last moment he had been notified that some Russian botanists were coming. That would make it necessary to call a special session of the Congress to provide a time and place for the Russian botanists to present their papers.

At the opening session H.R.H., The Crown Prince of Sweden, now King, entered after everyone was seated and sat in a lone chair in front of the first row of seats. Dressed in a morning suit and wearing a pink carnation in his buttonhole, he came upon the platform to open the Congress. In his address he referred to Linnaeus, the Swede of the 18th century, who is the Father of Botany. H.R.H. pointed out that botany, today, like other sciences, is being more and more subdivided, and that botanists are becoming specialists in subdivisions such as genetics, taxonomy, or cytology. He urged us to recognize the narrowness of outlook that comes from specialization and to think more upon the plant as a whole. He suggested that the real understanding of the plant might become greater through a wider outlook.

Action was then taken toward the organization of the VIIIth Congress—VIIIth because it will be the eighth international botanical congress in this century. Invitations were presented by France, Canada, and the United States. Our invitation was presented by Dr. Albert Blakeslee, Director of the Genetics Experiment Station, Smith College. He offered the invitation in a spirit of genuine hospitality, saying that there was no desire to compete with any other country and that we are willing to help with a Congress in Canada, if the Canadian invitation should be accepted.

Later, as I talked with botanists of several nationalities about invitations to the VIIIth International Botanical Congress, I realized that all of them wanted to come to America. An International Botanical Congress in Quebec, Canada, or Cambridge, Massachusetts—the two cities that had been named—would be a good excuse for a trip across the Atlantic. Once across, it should not be too difficult to visit New York, the

city everyone wanted to visit. France's invitation was finally accepted. So in the summer of 1954, instead of European botanists coming to America, Americans will be going to Paris.

His Majesty, the late King, had graciously invited the members of the Congress to a reception at the Royal Palace of Drottningholm on the afternoon of the opening day. His Majesty who was called "Mr. G" when he was traveling, was in the south of Sweden and H.R.H. The Crown Prince, acted in his behalf at the reception. We entered the Royal Palace in groups of twenty through the left of the three front doors. Each group made a complete tour of the rooms on the ground floor. H.R.H. shook hands with each of us in one of the inner rooms as we filed past. Then we went to the gardens where refreshments were served. We were offered sherry and open sandwiches, and after our sherry glasses were empty, champagne cocktails and pastries. It was a pleasant occasion.

CARL VON LINNÉ's garden in Uppsala. The pavilion which dates from his time is seen against a modern housing development. *Courtesy American Swedish News Exchange, Inc.*

You may wonder whether there was any serious botanical side to the Congress. There was. All botany was divided into fourteen sections. These met concurrently from nine to five. Papers in cytology, ecology, taxonomy, forest botany, bacteriology, physiology, and other subdivisions were presented throughout the days of the Congress. Specialists were talking. The language was English, German, or French. A Dane, an Egyptian, or a Brazilian spoke in either English, German, or French, not in his mother tongue. A Swedish botanist, whose home may have been in Stockholm, delivered his paper in one of the languages of the Congress, not in Swedish. However, the Russians spoke only in Russian, which necessitated providing a Russian-English interpreter.

On the Sunday of the Congress there was an all-day trip to Uppsala and to Hammarby, about six miles from Uppsala, to visit the town house and the country house of Linnaeus. This was a pilgrimage in which nearly everyone participated. Linnaeus' town house in Uppsala is in the corner of the garden where he carried out his important botanical work. Today, the garden looks exactly as it did when Linnaeus walked in it. On the right are the annual plants; on the left, perennials. In the background is Linnaeus' greenhouse. The dwelling house was Linnaeus' home for thirty-five years. It was restored by the Swedish government in 1937 and is now arranged as a Linnaean museum. In a cupboard in the dining-room is the magnificent strawberry bowl from which Linnaeus was served large quantities of wild strawberries as a cure for gout. Here is the tea set made in China and decorated with Linnaeus' flower *Linnaea borealis*, and wine glasses engraved with the same flower. On the wall of the dining-room is the oil portrait of Linnaeus that is copied so frequently that it is familiar to you. It is the one in which Linnaeus wears the dress of the Lapps. He is holding his favorite flower. I saw many of the flowers later when I was in North Sweden, as well as the Lapps dressed in the same costume.

Linnaeus' country estate in the village of Hammarby was purchased by him in 1758 and the present main building erected by him in 1762. This main building or summer residence is of wood, two stories high and painted a dark red with white trim. In the house are the personal possessions of Linnaeus and his family. The pendulum clock is still going.

On the same property in Hammarby is a small brick building. This was built by Linnaeus to house his collections of plants and to safeguard them from fire. After Linnaeus' death these collections were sold to an English botanist and are now in the care of the Linnaean Society of London. There is a story that Linnaeus' wife was so tired of having taken second place to these dried herbarium specimens all her married life, that when widowed, she sold them to the first bidder.

On the last day of the Congress it was announced that a wreath would be placed on the grave of Linnaeus. The wreath was to be presented by the botanists of all nations present at the Congress, with the exception of the botanists of one nation. Guess! The botanists of that one nation preferred to lay a separate wreath a few days after the wreath from the United Botanists had been placed.

In addition to the social gatherings, general meetings, section meetings, and trips in and near Stockholm, there was another very important part of the Congress. I refer to the scientific expeditions which were organized and conducted by the Swedish botanists. Much time and effort must have been given by them to these excursions. A printed booklet was distributed

(Continued on Page 63)

Guiding Science Students

• By T. H. Dunkelberger, Ph.D., *(University of Pittsburgh)*
HEAD, DEPARTMENT OF CHEMISTRY, DUQUESNE UNIVERSITY, PITTSBURGH, PENNSYLVANIA

This stimulating article on student guidance is characterized by sound common sense. The wide experience and good judgment of the author are reflected in each paragraph.

You will be interested in Dr. Dunkelberger's ideas concerning premature decisions, student desire and intellectual ability, the need for sound mathematical training, overcrowded professions, and guiding students OUT of science as well as in. He considers other topics that will suggest to the advisor sources of special help.

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The problem of guiding the science student is not different in principle from that of guiding any student. It involves primarily an evaluation of the student's abilities and interests and a knowledge of what to steer him toward or away from. Proper guidance involves not only advice about choosing a career, but also advice about the best preparation for such a career.

The problem has somewhat different aspects, however, depending on the level at which the guiding is done. At the high school level there is involved primarily direction with respect to scientific pursuits as a group, or at most with respect to some general branch of science. At the college level the possible professions under consideration must be greatly restricted, culminating, eventually, in just one or a very few. I may interject right here a warning against making the direction too specific at the lower levels. It is all right for a high school student to plan to be, for example, a chemist. It is troublesome and usually undesirable for him to plan to be, say, an expert in plastics.

The primary problem at the high school level, as I see it, is to get a sufficient definition of purpose to aid in selecting an appropriate college. If a student is, for example, set on being an engineer, there is nothing to do but advise him to go to a school of engineering. If, however, he is uncertain about his ultimate aim he might better go to a liberal arts school, take courses in several sciences, and let his interests and ambitions crystallize as he goes along. There is usually little danger in waiting to decide, provided only that he follows his interests conscientiously, does not take merely a haphazard collection of courses, and learns all he can. On the other hand, there are great dangers in deciding prematurely or deciding for the wrong reasons.

Premature decisions commonly result from parental pressures or from some dramatic or romantic appeal of the career. This is all too commonly the case with, especially, pre-medical students. Many of them have been told from the time they were toddlers by their parents, their Aunt Emma, and the man next door that they will some day be a doctor. They've never had anything to say about it themselves. When they discover that medicine is a collection of biology, chemistry, and worse, they are likely to decide that it is not for them. By this time, however, the wrong idea is so firmly fixed in the minds of other people that the unhappy victims do not feel that they can back out. This is, of course, an extreme case, but it does happen. The point is that the conscientious adviser must be as alert to the desirability of advising some student *out* as well as others *in*.

Since such premature decisions are found most commonly among pre-medical students and engineers, it is very important to inquire patiently of these students why they think they want to enter their chosen profession. Wise counsel here may not only eliminate an unhappy member of one profession but produce an excellent representative of another.

But the first problem is one of recognizing abilities and interests. The interests will usually manifest themselves automatically, and when they become apparent any good teacher will do his best to stimulate them in any legitimate way. It is possible, however, though admittedly not too common, to have high interest without the intellectual ability to back it up. For this reason a teacher should be reasonably well satisfied that the student is competent before deliberately exciting ambitions that probably can never be realized.

The best single criterion of scholastic possibilities is the composite grade of the student. This is a compliment to the fairmindedness and objectivity of teachers in general. We simply ask the question "Is he really a good student?" and answer it by reference to his accomplishment in our course and in other courses. Notice that the question is, "*Is* he a good student?" not "Is he bright enough to be a good student?" or "Would he be a good student if he worked?"

But in addition to teachers' grades external criteria are available to assist in determining competence: intelligence tests, standardized examinations, professional aptitude tests, and so on. Every school should have available the means for administering such tests, and every teacher should have available the results. The Duquesne University Testing Bureau cooperates in supplying such information about individual students.

If the student is definitely competent and is interested in a scientific career, there still remains the problem of directing him into the most satisfactory of the possible careers. Here it is important to be highly objective about his apparent interests and to try to advise him in a way that will make things work out best for *him*. Too often we are inclined merely to direct the student into our own field. We should always make allowance for a possible change of interest and encourage the student to arrange his preparation in such a way that

the change will involve the least possible readjustment and loss of time.

To be very specific, the greatest difficulty occurs in connection with mathematics. The need for good mathematical preparation is usually obvious to students preparing for careers in engineering or the physical sciences; it is less obvious for careers in, say, medicine. Nevertheless, it should be realized that increasing numbers of medical schools are demanding work in physical chemistry before admission, and any self-respecting course in physical chemistry presupposes a course in calculus. If a prospective physician does not realize this while he is still in high school and for one reason or another is allowed to slight his mathematical preparation, he is unwittingly seriously jeopardizing his chances of ever attaining the M.D. degree. It is my opinion that competent students will be well advised to take the maximum offering in mathematics regardless of what they may think they want to do later on.

This suggests another point. Advice must be realistic and not just routine encouragement. In addition to not encouraging mediocre students to tackle the most difficult professions, teachers should try to be acquainted with the probable demands for professional men in the various fields and advise accordingly. For example, the fields of civil, electrical, and mechanical engineering appear to be approaching saturation. Demands for dentists will no doubt decline during the next generation because of newer knowledge of how to prevent dental ailments. On the other hand, some fields like psychiatry are expanding faster than competent persons can be found to fill the needs. Knowledge of less well-known fields can also be helpful. I sometimes tell students that probably some of them would want to be anthropologists if they just had some idea of what anthropologists do for a living.

It is important, however, not to overemphasize the crowded condition in a particular field. The student should be led to believe that if he is *really* good there will *always* be an opening for him in any field he chooses. I am rugged individualist enough to believe this firmly, and I become quite impatient with the fatalists and futilists who are prone to blame their lack of success solely on lack of opportunities. Considerations of crowdedness should be interjected only when it is a toss-up in the student's mind as to which of several fields he prefers.

No teacher can be expected to be familiar with the great number of possible fields, and with the requirements for and opportunities in individual careers, but fortunately numerous aids are available. The series of pamphlets issued by the Institute for Research, Chicago, is particularly helpful. These cover about 100 possible careers in a rather detailed fashion. They should certainly be available in every high school library. Individual professional groups, particularly in the medical fields, also issue brochures giving information about what their profession is like. I might mention, for example, the Registry of Medical Technologists, the American Dental Association, and the American Optometric Association. There are also books about choosing careers and books about individual careers which might well be in every school library. In the field of chemistry, for example, I can mention: Coith: *So You Want to be a Chemist;* Grady and Chittum: *The Chemist at Work.*

I am sure there must be similar books in other fields, although I confess that I am not acquainted with them. These books will in general temper the romance of the professions with a discussion of some of the hard work, even drudgery, required to get ahead in them.

A particularly troublesome problem arises in connection with the student who is competent, enthusiastic, and who knows what he wants to do, but who does not have the financial backing to go to college. If the student is exceptionally competent many sources of potential aid are available, for example: State scholarships, Senatorial scholarships, County scholarships, scholarships awarded by individual colleges.

Most of these are awarded on the basis of examinations. It is important, therefore, to see that the student is acquainted with the time, place, and nature of such tests. Fortunately, most of these examinations are well publicized in the high school, and it is necessary only for teachers and students to read the announcements.

There are also other activities which do not lead directly to scholarships but which will be helpful in securing scholarships from other sources, for example in the Pittsburgh District, Westinghouse Talent Search (national in scope), Buhl Planetarium science show, Pittsburgh Section chemistry test.

High scorers in these activities are very commonly offered scholarships by some college.

This discussion has obviously considered almost exclusively the student who will go to college, because it is doubtful whether the non-college student will ever get into a career that is truly scientific. It is true that some high school graduates do become laboratory technicians, but it is my impression that such opportunities are dwindling and will essentially disappear as more and more college graduates begin to compete for the same jobs.

Also, I have spoken only of *students* and have not differentiated between boys and girls. It would be futile to argue that girls have equal opportunities with boys; nevertheless, I would not and do not hesitate to advise girls to seek careers in science. They need, I think, somewhat more careful guidance in the selection of the specific career, as some fields, engineering for example, are particularly difficult for girls to enter. Even if their aim is only to get married one could do worse than direct them into a scientific field because the men scientists with whom they would work allegedly make particularly satisfactory husbands. It is a well publicized fact, for example, that the divorce rate is lower for chemical engineers than for any other professional group.

All these things I have mentioned are fairly obvious and are probably well known to you. The important thing is for the teacher to be sincerely interested in having the student reach the highest level of usefulness and happiness of which he is capable. ●

NEW BOOKS

Textbook of Anatomy and Physiology

• *By* CARL C. FRANCIS and G. CLINTON KNOWLTON. St. Louis: The C. V. Mosby Co. 1950. Pp. 624. $6.25.

Textbook of Anatomy and Physiology

• *By* CATHERINE P. ANTHONY. St. Louis: The C. V. Mosby Co. 1950. Pp. 614. $4.00.

These textbooks, both revisions of earlier editions, are intended to fulfill the needs of nursing students who are taking a combined course in anatomy and physiology. It goes without saying that a knowledge of anatomy is necessary to an understanding of physiology. But to write an effective text which presents these two subjects in an integrated and coherent whole is not easy.

The text by Francis and Knowlton seems generally adequate for its purpose. The authors' style is readable and the organization of the text is good. The various topics are covered satisfactorily. There are numerous anatomical illustrations (including a number of color plates) which are helpful. The chief defect appears to be in a few erroneous statements. So far as this reviewer is concerned, he is not aware that "trypsin is a complete protein ferment in that it will promote the breakdown of protein to amino acids" (pp. 470, 478), "thyroxine is built upon tryptophane" (p. 495), and "ammonia is formed [in the kidneys] from urea" (p. 519). The authors do not feel justified in listing deamination and pernicious anemia in summarizing the various functions of the liver (p. 475). They also fail to include leucine as an essential amino acid (p. 495). Both folic acid and vitamin B_{12} are omitted from their discussions on vitamins. Linoleic acid is described as an essential fatty acid, but no mention is made of either linolenic acid or arachidonic acid (p. 505).

The text by Anthony represents an attempt to present anatomy and physiology in a systematic and concise manner. The text achieves the distinction of containing a considerable amount of material in concentrated, outline form, but how effective it is in teaching is problematical. Because of its highly condensed nature, it is not easy to read. The text is well organized and it has a substantial number of illustrations (but less than the other text). Few errors were found. Contrary to the claim of the author, it is known that some of the amino acids pass through the liver intact after absorption from the small intestines (p. 461). It would seem inappropriate to call fibrinogen a drug (p. 312).

F. I. Tsuji, Ph.D.
School of Pharmacy
Duquesne University

Active Carbon

• *By* JOHN W. HUSSLER. Brooklyn, N. Y.: Chemical Publishing Co., Inc. 1951. Pp. VI + 384.

This book, written by the Director of the Active Carbon Research Nuchar Laboratories of the West Virginia Pulp and Paper Co., reflects 35 years of experience in the manufacture and marketing of active carbon. Two previous publications by the author were well received, and are still in use in private laboratories to implement the testing and process controls employed in manufacturing this useful material. The present publication could well be made required reading for students of chemistry and chemical engineering because of the importance of activated carbon in industrial chemical operations. Active carbon is the most essential component of industrial and military gas masks.

The book is divided into three parts which deal with Preparation and Properties, Applications, and Experimental Methods. In the first part, commercial manufacturing processes are considered. Adsorption and catalysis are given an elementary treatment, and mathematical derivations and applicable equations are omitted. The Freundlich equation on adsorption is stated in its simplest form and illustrated by the isotherm for the adsorption of ethylene at 0° C.

The second section dealing with the applications of granular and pulverized active carbon in liquid and gaseous phases is replete with helpful information in such diverse fields as sugar technology, water and air purification, pharmacology, catalysis, and solvent recovery.

The final section considers the principles involved in the procedures for examining the properties of active carbon. The methods are described adequately and in sufficient detail to illustrate the various techniques employed. The book is well documented with numerous references at the end of each chapter.

John F. Matejczyk
Coordinator of Research
The O. Hommel Co.
Pittsburgh, Pa.

Words and Their Use

• *By* STEPHEN ULLMAN. New York: Philosophical Library. 1951. Pp. V + 108. $2.75.

A work which is designed to fit into the scheme of a popular series, as is Stephen Ullman's *Words and Their Use*, will be general in treatment rather than profound, simple rather than complex. This is evident in Professor Ullman's handling of his subject for even a few of the jokes he used when delivering his lectures

are retained to lighten the burden of such detail as it is necessary for him to use. *Words and Their Use* is concerned with the meanings of and attitudes toward words that operate in the development of a language vocabulary. It is not concerned with the grammatical or syntactical functions of words. The style is easy and familiar and the author is familiar with much that has been written on his subject, and what is surprising, considering the fact that he is an Englishman, even much that has been done by Americans. An intelligent reader will learn a good deal from it.

J. M. Purcell, Ph.D., Chairman
Department of English
Duquesne University

Selected Invertebrate Types

• *By* FRANK A. BROWN, JR., Editor. New York: John Wiley & Sons, Inc. 1950. Pp. XX + 597. $6.00.

For many years instructors in invertebrate zoology have had very little from which to choose in the matter of selecting an adequate laboratory manual for their classes. This volume is an attempt on the part of the staff of the Department of Invertebrate Zoology of the Marine Biological Laboratory at Woods Hole, Massachusetts, to satisfy the need for a comprehensive yet efficient laboratory guide.

This book is completely different from the conventional type of manual. There are more than 500 pages of concisely-written material, describing both the anatomy and physiology of more than 125 different species of invertebrate animals. In addition, the authors have included other pertinent information, such as habitats, methods of collecting, culture methods and techniques for study in the laboratory. The illustrations are adequate, but not exceptional.

The book is especially designed for classes which are fortunate enough to have living specimens available for study. Some instructors may find this aspect a disadvantage. The reviewer has used this volume as a combined textbook and laboratory guide for graduate students. It proved to be quite satisfactory when supplemented by the regular lecture work.

Lois Cribbins, Ph.D.
Department of Biology
Duquesne University

Textbook of Organic Chemistry

• *By* E. WERTHEIM. 3rd Edition. Philadelphia, Pa. The Blakiston Company. Pp. 958. $5.00.

Those who are familiar with the second edition of this well known text will find the new one essentially unchanged in its general character. The author introduces into this edition some of the modern ideas of theoretical organic chemistry, but does it with restraint. It is the impression of this reviewer that the author is unconvinced of the desirability of including modern theory in the first course, and that the limited discussion of theory presented herein is a compromise with the general trend of the times.

It is questionable whether the student should be permitted to see examples of nomenclature such as "dimethylpropylmethane" (p. 43), or "ethanenitrile" (p. 323). The inductive effect on p. 17 is not clearly presented and in the mind of the student may become confused with the polarity of many covalent bonds. Inconsistent with the octet limitation for nitrogen are the structural formulas containing pentavalent nitrogen atoms (pp. 280, 281). The writing of two separate structures for potassium succinimide (p. 292) is also inconsistent with the resonance theory. It is the personal opinion of the reviewer that there is no need to confuse the beginner with a less accurate presentation of material at the beginning of the course, following with a more accurate presentation at the end. Another illustration of this point is the outdated mechanism for the Claisen condensation on p. 238 which is brought up to date on p. 872.

The printing and binding of this book are very satisfactory.

H. H. Szmant, Ph.D.
Department of Chemistry
Duquesne University

The Young Scientist

Activities for Junior High Students

• *By* MARTLAND P. SIMMONS, B.Sc., M.A., New York: Exposition Press. 1951. Pp. XII + 164. $3.00.

The teacher of general science, who should be the most highly qualified member of the high school science staff, too frequently is not. He should have breadth of science background and keen interest in his work. He may need personal stimulation and inspiration. But always he welcomes suggestions for individual and group activities, and practical teaching helps for the classroom. Consequently, every ninth-grade general science teacher should find this book useful. Designed to supplement the usual textbook, it describes a large number of "experiments" suitable for group demonstrations that can be performed before the class by pupils. Expensive apparatus and materials are not required. The description of each activity is prefaced by a list of questions that are to be answered before the demonstration is performed, and followed by others that encourage the pupil to make useful applications of the principle involved. The 35 illustrative line drawings add interest and clarity. There are "Notes to The Teacher" and a glossary of science words.

H. C. M.

The American College Dictionary.

Text Edition

• *Edited by* CLARENCE L. BARNHART. New York. Harper and Brothers. 1948. Pp. XL + 1432. $5.00.

A bargain in dictionaries. Some 535 authorities and specialists in 316 fields of knowledge cooperated in preparing it. College students and workers in homes and offices everywhere will be thankful for this book because of its 132,000 entries, its 1600 illustrations and spot maps, its accuracy, its readability, its clarity, its up-to-dateness, its moderate size.

The single alphabetical listing of all terms makes it easy to find a word. There appear to be fewer cross references than are usual in a desk dictionary. An idea of the completeness of definition may be judged from the fact that for the word "scale," 41 numbered definitions are listed. The definitions most frequently used are given first, followed by the older and less frequent uses. The type selection is good. Pronunciation is plainly indicated. *H. C. M.*

From the Life of a Researcher

• *By* WILLIAM WEBER COBLENTZ. New York. Philosophical Library. 1951. Pp. 238. $4.75.

This informal, frank, and in many ways delightful autobiography was written somewhat reluctantly to fulfill the requirement that each Academician must file in The National Academy of Sciences a statement of auto-

(Coninued on Page 71)

Meteoritics and Navigation

(Continued from Page 51)

The systematic collection and study of the smallest of the solid survivors, the meteoritic dusts, is a field requiring for its cultivation only the simplest and least expensive equipment, but from which results of great value have already been derived[1]. Somewhat over a century of intensive study of the larger recorded survivors, the meteorites, has shown that they may be subdivided into three great classes: the irons (masses of nickel-iron alloy), the iron-stones (consisting of a nickel-iron network the interstices of which are filled with silicate minerals), and the stones, or aerolites (masses of silicate minerals with inclusions of metallic alloys and sulphides). Most of the witnessed falls now occurring are stones, of which more than 90 per cent belong to the subclass of *chondrites*, i.e., stones made up of chondrules embedded in a groundmass of pyroxene and olivine, in contrast to the *achondrites*, which exhibit no such chondrules. This fact only serves to emphasize the extraordinary character of the recent (February 18, 1948) shower of stony meteorites in Kansas and Nebraska, for this fall was not only record-breaking in the size of the main mass (Figs. 1, 2 and 3), which is the largest meteorite of witnessed fall so far recovered anywhere in the world, and in the integrated weight of the meteoritic material brought down to earth; but, *mirabile dictu*, the fallen meteorite was found to belong to the rare class of achondrites. In fact, it now serves as the type stone of a new achondritic subclass.

The startling phenomena accompanying this most remarkable of all aerolitic falls, and the scientific significance of the existence of such meteorites as the Nortonite, have been treated in detail by the writer[2] and need not be repeated here; but in passing, it seems worthwhile to note that the next to the largest fragment (131 pounds) of the Norton achondrite was found by a 14-year old school boy, Ralph DeWester, whose interest in things meteoritic had been aroused by the A-bomb-like explosions and clouds produced by the Norton fall and the search expeditions sent into his neighborhood by the Institute of Meteoritics. DeWester's discovery and the ease with which collections of value can be secured by those willing to expend the little toil, ingenuity, and money necessary to gather "cosmic dust" should make clear that meteoritics is one field where the non-professional can make contributions of genuine scientific importance; but additional evidence of this fact is easy to marshall. The dean of all meteoric astronomers, Professor Charles P. Olivier of the Flower Observatory of the University of Pennsylvania, President of the American Meteor Society, has for decades stressed the importance of meteor observations made by the diligent visual observer; and the writer can vouch for the fact that anyone who systematically watches, either in the field or in rock, rock-garden, and mineral collections, for exceptionally heavy (generally of density greater than 3) "stones," fragmental or otherwise, with rounded corners and edges, will sooner or later find a meteorite. In case the discovered masses are coated, at least partially, with a dark- to reddish-brown crust, exhibit "thumb-marks" or piezoglyphs, or, in particular, can be shown by grinding to consist even in small part of a shining, malleable, silvery metal resembling stainless steel (which indeed is an article of commerce patterned after the natural nickel-iron alloys first found in the meteorites), then the discoveries are quite likely to be meteorites.

When specimens pass any or all of the recognition-criteria set forth above, small samples of them (approximately the size of a ping-pong ball) should be sent for exhaustive chemical and microscopic study to the Institute of Meteoritics of the University of New Mexico. Such definitive testing is performed without charge, and, in case the samples studied prove to be genuinely meteoritic, negotiations are at once entered into with the purpose of securing, by purchase or exchange, the entire specimen from which the sample came for the meteorite collection at the Institute of Meteoritics. From this collection, in turn, specimens are made available by the Institute, on a loan basis, to the nuclear physicists, ballisticians, aero-dynamisticians, and other scientists engaged in research of value to meteoritics and basic to the scientific development of etheronautics. In fact, one of the main objectives of the Institute is to enable etheronauts and other investigators to secure *without cost* meteoritical specimens in such amounts as they may require for experimental purposes, thus enabling scientists to escape from a state of affairs which has led two prominent mineralogists to complain that "Meteorites are held at such an artificially high value by dealers and collectors as to make it difficult to secure any large quantity of any fall[3]."

As indicated above, valuable contributions in certain branches of meteoritics can be and have been made by the alert amateur as well as by the interested professional nonmeteoriticist; but there are other branches of meteoritics where only the specialist can really help effectively. A single example of this sort of inter-science cooperation must suffice. Photography of meteoric phenomena (which must necessarily be of exceptional luminosity to be recorded at all) belongs to the 20th century; sketches made by scientific observers carry the record but little back of the 19th century; only worded descriptions seem to have come down to us from earlier times. Nevertheless, the discovery and recognition of what have quite properly been called "meteoritical pictographs" shows that the American Indians and other aborigines (possibly even those of paleolithic times), left pictorial records of meteoric phenomena[4]. The importance from the viewpoint of chronology of the joint labors of astronomers and such collectors and collators of ancient *written* records of comets and meteors as Pingré and Biot has long been recognized. It seems quite likely that equal cooperative effort expended on the voluminous *pictographic* record of the past by archeologists, anthropologists, ethnologists, and meteoriticists would lead to results of comparable importance. ●

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Botanical Congress

(Continued from Page 57)

to each participant of every excursion. The booklet told where the group would go day by day, and what plants and plant habitats would be seen. These field trips to different parts of Sweden were from four to eighteen days in duration and taken for the purpose of observing, photographing, and collecting plants.

I signed for the Phytogeographical Excursion to the Mire Districts in North Sweden which was under the leadership of Dr. Hugo Sjörs of the Institute of Plant Ecology, University of Uppsala. On this excursion we saw plants from all the main groups and plants from a great many habitats, underwater, bog, meadow, forest and mountain top. We traveled by rail in slow stages from Stockholm northward, across the Arctic Circle to the end of the railway line in Swedish Lapland. We never spent more than three nights in the same place. We slept in sleeping cars, small inns, and at one time in tents. We were in the field all day long, rain or shine, weekday or Sunday. Lunch was a simple picnic which was eaten wherever we happened to be. We wore knapsacks in the field to hold lunch, raincoat, camera, extra sweater, and plant specimens. During the last week when we were camping in the far north seven miles from a dirt road, my entire wardrobe was limited to what I could carry in my knapsack.

The ten of us who took the North Sweden Excursion were of seven nationalities, Swedish, Swiss, Finnish, French, German, English, and American. Any language was spoken but German and English were used the most. When we were camping in tents the Englishman and I tried to teach the group some songs in English. We decided on a round, because of the simple words and the definite rhythm. So by an open fire in a primeval forest in Lapland an international group sang "John Brown's Body Lies A'mouldering in the Grave." We ventured even the variation in which words are dropped gradually at the ends of the lines.

When we were camping we took two cooks into the forest with us. They had to walk the seven miles in and out of camp with packs as we did. While we were away from camp each day on a field trip they were preparing good meals for us. It was camp food de luxe.

The food on the excursion and in general throughout Sweden was varied and bountiful. In my diary of the excursion I have described one of the moderate breakfasts as a "magnificent affair." That breakfast menu was boiled potatoes, creamed spinach, boiled eggs,

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When the railway train crosses the Arctic Circle the engine whistle is blown twice. There is a row of white stones which indicates the position of the Circle, and a sign. The sign gives the number of kilometers in one direction to the North Pole and the number of kilometers in the other direction to the Equator. The Arctic sun in summer is warm and brilliant and shines about 22 hours of the 24 so that it is never really dark. That made sleeping difficult. My very best sleep was in a sleeping bag in a tent. The hood of the sleeping bag kept out the night-long light. However, I had another worry. As I laced and buttoned myself securely in the sleeping bag, I used to wonder if I should ever be able to get out in the morning.

In the forests of the Arctic we saw herds of semi-domesticated reindeer. They were there to escape the heat of the summer in southern Lapland. The herds were not watched either by dogs or by their Lapp owners. No Santa Claus was with the reindeer either. The Lapp civilization is based on a reindeer economy. The Lapps are nomads and with their household possessions follow the annual migration of the reindeer. The Lapps milk the reindeer; make cheese of the milk; eat the reindeer steak, which I found delicious; use the skins; and train some of the reindeer to be draught animals.

We saw several families of Lapps. They are short of stature; the men average only five feet in height. The men, women, and children wear bright costumes. They are of a dark blue or green and are bound with red, yellow, and green bands on the shoulders, across the chest, down the sleeve, around the hem of the sleeve, and around the hem of the long jacket. The man's cap has a pompom of bright red wool yarn about eight inches in diameter. It is a costume such as this that Linnaeus wears in the portrait that is so well known. However the type of hat that Linnaeus wore is not seen on the modern Lapp.

The VIIth International Botanical Congress was a most pleasant and profitable experience. It was stimulating to meet botanists from other countries; to see new scenery; to enjoy new experiences, especially the excursion to North Sweden.

I hope that some day when there is an International Congress in your individual scientific interest, you will be able to attend. ●

★ ★ ★ ★ ★

"Science as fact is neutral, with great possibilities for evil looming up behind its neutrality. As a method of inquiry, however, it can only be regarded as on the side of the angels and as offering a positive basis for hope."

—*Julius Seelye Bixler*
in *Mid-Century*

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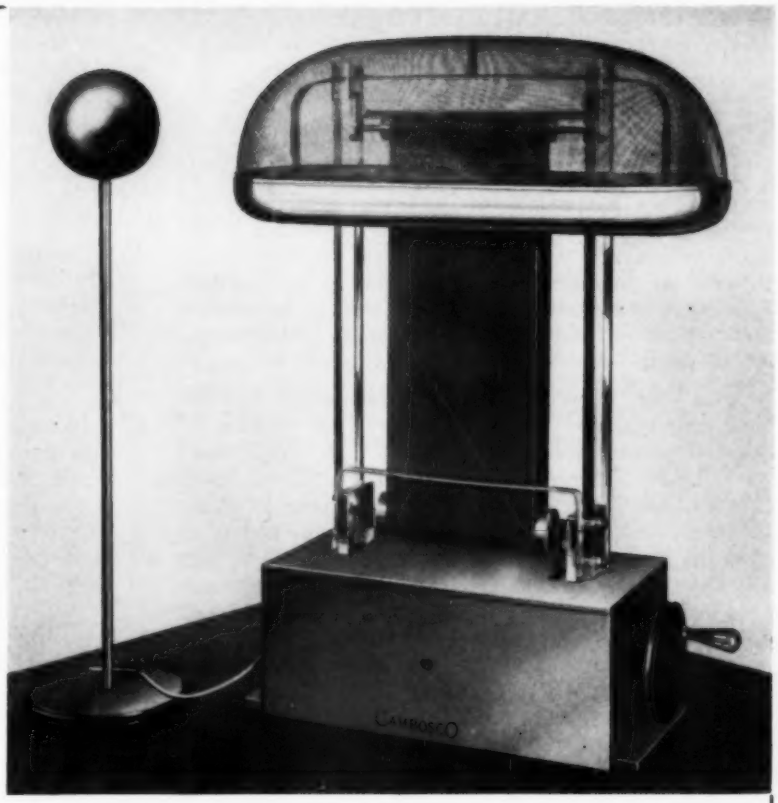

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Principal dimensions are as follows: Height, overall, 21-3/4 in. Width of terminal, 16 in. Width of belt, 5 in. Size of base, 6 x 13-1/2 in. Diameter of discharge ball, 3-1/2 in.

NOTES

•So named because a spark is produced at the first turn of the crank.

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▲A conservative rating, based on many trials under average operating conditions. Under ideal conditions, a potential difference of 300,000 volts has been achieved.

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Wartime Camouflage

(Continued from Page 40)

World War II. Camouflaging of airfields is a difficult task because of their size. However, application of texture materials to runways, the use of trees or nets to hide planes and as little scarring of the terrain as possible help to conceal an airfield. Sometimes the camouflaging of airfields is limited to toning down highly reflecting surfaces to make the field as inconspicuous as possible. Concrete runways are painted black and exposed soil is covered with oil or an asphalt emulsion to darken the surface and reduce the formation of dust.

Naval ships, especially the large battleships and airplane carriers, are difficult to camouflage because of their size and the wake they produce. The Navy, which has had some success in camouflaging ships, especially from observations at long distances, practices two general types of camouflage painting. One method is to paint the ship a battleship gray which in general permits the ship to blend fairly well with the water. Another method is to paint the ship a "zig-zag" or "dazzle" pattern of black, white and gray as illustrated in Figure 2. These patterns have the effect of appearing to reduce the size of the ship and confusing the viewer as to the direction in which the ship is traveling.

Camouflage is useful, not only in concealing troops in the field, but to hide rear-line and fixed civilian installations. Such installations are much more difficult to conceal because of their size than are combat troops and equipment in the field. In fact, it is impossible to camouflage large cities effectively. Some industrial plants, even though they are large, can be concealed from aerial observation. An excellent example of this type of camouflage in World War II was the Glenn Martin Airplane Plant near Baltimore, Maryland. By means of disruptive painting and nets to which painted steel and glass wool were fastened, this plant was amazingly well hidden from the air at altitudes above 4,000 to 5,000 feet.

One of the best methods of camouflaging industrial plants is to break up large buildings into small buildings chiefly by means of the application of paint. Shadows are imitated by the use of black paint. Whenever an industrial plant is near a familiar landmark, it is very difficult to camouflage it effectively from the air. Another difficulty with the camouflaging of industrial factories is the usual high towers, chimneys and water tanks which are very difficult to conceal. Windows present a problem which is usually solved by painting them a dark color.

If camouflage is considered prior to the construction of a civilian installation, effective natural camouflage can be utilized. One important factor in planning a camouflaged installation is to choose a spot which does not have a prominent landmark, such as a bend in the river, a peculiarity of the shore line or a prominent hill. It is important to construct the installation in a number of small buildings rather than in a few large buildings. These buildings should be irregularly distributed throughout the area. It is also important to have flat roofs. If the buildings can be well dispersed in a wooded area, their concealment is fairly easy. Roads should be narrow and winding and cars should be parked under trees. Trees should be planted as close to the buildings as possible or if the buildings are constructed on wooded land, as few trees as possible should be cut. The ground should not be scarred any more than is necessary and the planting of trees, bushes and grass should be used to hide scarred land. An excellent example of a well camouflaged installation is the Engineer Board buildings at Fort Belvoir, Virginia. Camouflage was an integral part in the planning of the installation with the result that the buildings are very difficult to see from the air.

In summary, camouflage is used in wartime to conceal personnel, equipment, supplies and troop movements in the theatre of war. It is also used to disguise important civilian installations to prevent their being bombed from the air. The main principle upon which most camouflage is based is the matching of the natural surroundings in color, shape and texture. ●

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Chemical Weed Control

(Continued from Page 47)

Although the 2,4-D compounds are specific for broad-leafed annuals, most grasses are not affected. Even so, there is considerable variation in response among broad-leafed plants. The stage of growth at which weeds are treated is important. Many weeds that are sensitive to 2,4-D in the seedling or early growth stages may become more resistant later. Weeds like marsh elder, mustard, plantain, dandelion, and burdock are very sensitive to 2,4-D. Annual sow thistle, button weed, cocklebur, pennycress and small ragweed are also somewhat sensitive. Bedstraw, lamb's quarter, mallow, smartweed, shepherd's purse may be classed as semi-resistant. The black nightshade, catchfly, bouncing Bet and milkweed are resistant. Perennial weeds like Canada thistle, perennial sow thistle, European bindweed require repeated applications.

Developing seedlings, even those of many grasses, are sensitive to 2,4-D. This information has led to considerable experimentation to determine whether it is possible to treat the ground after the crop seeding has been finished and before the seedling has appeared. In this pre-emergence treatment, the 2,4-D is sprayed on the surface. Since the weed seeds are near the surface, they are killed as soon as they begin to germinate. The planted crop seed being at a lower depth does not come in direct contact with the 2,4-D.

For the successful manipulation of this pre-emergence treatment, there must be sufficient moisture in the soil for the crop seed as well as the weed seeds to germinate. If the ground is too dry, the 2,4-D material will be dissipated without accomplishing any definite result. If heavy rains fall shortly after the application of the 2,4-D, the herbicide may come in contact with the germ-

inating crop seed. In order to stabilize pre-emergence practice, it may be possible to add materials which will make the 2,4-D less soluble or to use new compounds which are specifically adapted for this type of action.

A large number of the phenoxyacetic acid compounds have been tested, but comparatively few of these are as effective as 2,4-D. 2,4,5-T has recently been found to be a better herbicide for certain brushy weeds, like brambles and Osage orange. Mixtures of 2,4-D and 2,4,5-T are now being recommended for the control of brush where a mixed population is present. It has been found, too, that young trees can be killed during the dormant season by spraying the basal stem to a height of two feet with 2,4-D and 2,4,5-T. Methoxone (2 methyl-4-chlorophenoxyacetic acid) now available in the United States, has been extensively used in England. This herbicide has proven to be particularly good for the control of weeds in flax and peas.

Since 2,4-D has been of great help in the elimination of broad-leafed weeds, the control of weeds of the grass family by the use of chemicals has not progressed as far. In many cases where 2,4-D has been used, the broad-leafed weeds have been eliminated but the grassy weeds have become more plentiful. Several years ago IPC (Isopropylphenylcarbamate) was introduced as a specific herbicide for weeds of the grass family, but the experimental results with this material have been disappointing. From recent experiments it appears that IPC may have some value in controlling grasses in forage crops such as alfalfa and ladino clover.

TCA, chemically sodium trichloroacetate, has given good results in the control of quack grass. Combined with cultivation, the amount necessary to eradicate quack grass has been materially decreased. The material acts through the roots and the rhizomes. TCA in amounts of 5 to 10 pounds per acre has given good foxtail control in sugar beets when pre-emergence treatments have been made.

It is not to be expected that chemicals will supplant good agricultural practices. Since cultivation is largely to control weeds, much time, labor and expense in the growing of a crop may be saved through the intelligent use of herbicides. The planting of crop seeds free of weed seeds will be as important as ever. Newer and better herbicides will be developed. As more is learned concerning the specific action of the chemical itself and its action in the plant, a more intelligent use of herbicides is bound to take place. ●

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"Science, as even Dr. Einstein would be the first to admit, will stand forever on the threshold of the unknown. When it stands there, it stands on the threshold of the spirit, on the threshold of God."

—*Henry Suydam*
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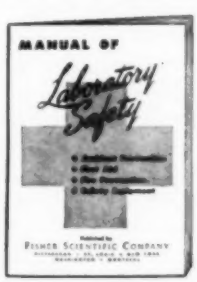

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The Heat Pump

(Continued from Page 49)

would reduce operating efficiency of the refrigeration system.

Tests of heat dissipation were made by circulating water at 90, 100, 110, and 120 degrees F. The results at 120 degrees were incomplete since cool weather overtook the project during these runs. The results from the dissipation tests were even more disappointing than those involving receipt of heat. The solar energy incidence of 2000 - 2500 BTU per square foot per day made heat dissipation quite difficult through a coil close to the surface as required for winter heat absorption. In order to get sufficient temperature difference for heat transfer, the circulating temperature would be so high as to seriously affect operating costs of a refrigeration system.

The story of the results can best be told by considering two sets of curves. Figure 2 shows comparative costs of operating a 20 horsepower heat pump for heating. These were based upon a COP of five. Direct expansion refers to circulating the refrigerant through the source coil, while indirect expansion refers to circulating some auxiliary medium and using heat exchangers. Operating costs per unit of refrigeration for smaller units would be slightly higher, since efficiency decreases with size in refrigeration units.

Figure 3 shows the tubing requirements for various circulating medium temperatures. This is more or less independent of tube size, since the conductivity of the fluid and the tubing are very high compared to that of the soil. The tube size would be based upon allowable flow losses and material availability. These curves are based upon a minimum soil temperature of 50 degrees F., and a coil similar to that installed.

As an example, consider an installation for a residence requiring 50,000 BTU per hour heating in winter, and 25,000 BTU per hour cooling in summer, using direct expansion with Freon 12 as the refrigerant. Assume a COP of four for cooling, and consequently, five for heating. Also assume a condensing temperature, or fluid temperature of 115 degrees F., corresponding to a condensing pressure of 146 pounds per square inch gage. This is a high condensing pressure, but still safe.

The coil would have to dissipate 25,000 plus 25,000/4 or 31,500 BTU per hour. From the curves, the tubing requirement would be 133 feet per 1000 BTU per hour, or a total of 4190 feet of tubing. For winter heating, 50,000 less 50,000/5 or 40,000 BTU per hour would be required from the coil. 4190/40 or 105 feet of tubing per 1000 BTU per hour would be available. From the curves, a circulating temperature of 41 degrees F. would be permissible.

Estimating an installed cost of 33 cents per foot of tubing, the cost of the installed coil would be $1382.

For a coil of this type and size, a total area of 4190 times 2 or 8380 square feet would be required. This would correspond to a plot 65 feet by 65 feet.

A residence requiring loads as low as those used would probably not be of such value as to justify such an installation, and would probably not have sufficient space for installation of the coil.

The heat pump may be a gold mine, but mining costs are high. The COP's for cooling of four and five for heating are rapidly overshadowed by other factors. Unless low cost power, and a low cost source of heat and sink for heat are available, the heat pump is not nearly so attractive as it first appears. ●

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From Seeds of Grass

(Continued from Page 42)

15,000 years; and for thousands of years these were the principal cereals raised there. In the New Stone Age in Europe two-grained wheat was under active cultivation in a wide belt extending from the lower Danube to Denmark, and in the classical period its cultivation was extended along the coast of northern Africa and to Greece, Italy, and Sicily. But today it is rarely raised as a food for man.

Spelt apparently came into being in comparatively recent times, perhaps in southeastern Europe or southwestern Asia, from a crossing of two-grained wheat with a species of grass, and was carried over the northern route into central and western Europe. The earliest certain finds of spelt in temperate Europe belong to the Bronze Age and are confined to Switzerland.

To turn now to the so-called naked wheats, several distinct species have arisen from two-grained wheat by hybridization, among them rivet wheat, Polish wheat, and durum wheat. The first two are of negligible importance and apparently of recent origin. Durum wheat is rarely used for making bread, but is extensively employed for the manufacture of semolina for use in alimentary pastes, such as macaroni, spaghetti, and vermicelli, and is better suited for such use than the usual bread wheat. It may have existed as early as the classical period, although this is doubtful, and in any event it could have played no significant role as a bread cereal.

Both one-grained wheat and two-grained wheat were under active cultivation in Switzerland in the New Stone Age. In addition, the lake-dwellers of that era raised a type of wheat somewhat similar to club wheat, a naked form which probably arose from a crossing of one-grained wheat with a type of wild grass that grew in that region. Some time after spelt reached this section—and this could not have been sooner than the Bronze Age—it apparently hybridized with the naked wheat raised by the lake-dwellers and gave rise to the naked club wheat and common or bread wheat as segregates. These then spread south to the Mediterranean lands, where they entered into competition with well established forms of two-grained wheat. The latter were actually better suited than common wheat for

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use in the thick mushes that were in general use in countries ringing the Mediterranean, and it was therefore not until the art of bread-making had progressed to the point of baking superior raised bread that the advantages of common wheat for this purpose could find expression in increased production. This did not occur until the classical period.

The general course of development, accordingly, was approximately the following. In the earliest stage the seeds of various wild grasses, including wild forms of wheat, were gathered as a food by man, forming a part of his varied diet. In that era only hulled forms of wheat existed. Some of these later were taken under casual cultivation, but in Egypt and Mesopotamia two-grained wheat was singled out for special attention and in time became well established there. Later, in Switzerland, remote from the fertile crescent, by an accident of hybridization excellent forms of naked wheat came into existence, among them common wheat. The brittle rachis and the invested seeds of the hulled forms were a disadvantage, but not sufficiently so to outweigh their greater suitability for the mushes which were prevalent in Mediterranean lands. It was therefore not until excellent bread began to be made that common wheat could meet this competition, and then it gradually gained the ascendancy, to such a degree that in time it became almost the only wheat used for making bread. ●

A Welch Service

The W. M. Welch Manufacturing Company, Chicago 10, Illinois, is making available free of charge to science and biology instructors a little booklet entitled, *A Living Biological Laboratory*. Written by M. E. Smallwood, the booklet is packed with information concerning the laboratory care of animals. Teachers will be glad to have this information so readily available.

★ ★ ★ ★ ★

"Unless we keep in mind that teachability on an elementary level is one of the great assets of science, and accordingly stress rigorous instruction in fundamentals, science has little more justification than law in the general education program."

—KONRAD B. KRAUSKOPF

★ ★ ★ ★ ★

"Historically, it has been agreed that a university is a place of universal knowledge or a collection of colleges. A college, on the other hand, has no necessity of being a place of universal knowledge, for it is primarily a place of *teaching. A college is a society.* It is made up of learners and teachers living together for the purpose of human growth."

—D. ELTON TRUEBLOOD

Amino Acids

(Continued from Page 38)

cludes substantial amounts of those proteins (milk, eggs) known to contain the ten essential amino acids in suitable quantity.

The process of digestion and assimilation which a food protein undergoes in the alimentary tract is essentially one in which the protein is broken down into its constituent amino acids by the action of specific enzymes found in the stomach and intestines (pepsin, pancreatin, etc.). These individual amino acids are then conveyed by the blood stream to points where they are "re-assembled" into new protein tissue in accordance with existing and specific local requirements.

The breakdown of protein into individual amino acid components by means of enzymes can also be accomplished outside of the animal body, using animal enzyme preparations obtained as by-products of the meat packing industry. This is one of the methods occasionally used in the production of amino acids. Another method is to digest the protein for several hours in strong hot acid or alkali. Whether the digestion is accomplished by enzymes or by hot acid (or alkali) the process is known chemically as one of "hydrolysis," and the result is a mixture of the amino acids.

Amino acid mixtures, prepared either by enzyme or by acid hydrolysis of protein, are produced commercially and marketed as such, usually being designated as "protein hydrolysate." Actually this type of amino acid mixture serves as a "pre-digested" protein, in which the amino acids are ready for assimilation without need for any further digestion in the stomach or intestine. Some of these mixtures are intended for administration by mouth, while others are given by intravenous injection.

Near the close of the last World War there was a prevailing assumption that persons who were near death from famine or from prolonged starvation in prison camps would probably have suffered impairment of their digestive functions to such an extent that they would need to be fed protein hydrolysates until there could be a restoration of natural digestive processes to the extent of permitting a resumption of normal practices involving the feeding of intact protein materials. Actually this assumption was not confirmed, for it was found that any person who had reached such a state of nutritional collapse that he could not digest whole proteins was beyond all possibility or hope of survival under any conditions. Accordingly, the useful application of amino acid mixtures such as are found in protein hydrolysates has been limited for the most part to the treatment of patients in special situations where there is interference with the normal processes of food digestion or assimilation. Such cases are encountered, for example, in unusual forms of allergy, in cases of peptic ulcer and in surgery involving the alimentary tract.

Individual amino acids, in the pure, dry state, are crystalline substances resembling salt or sugar. They can be prepared either by isolation from protein hydrolysates, or by synthetic methods. For most of the amino acids, either process involves costly operations, with the result that when purchased individually and in pure form they are very expensive and with a few exceptions they are available only in relatively small quantity. Prices for the several amino acids, in the pure crystalline state, range from slightly less than $2.00 per pound (for glycine in drum lots) to approximately $500.00 per pound (for threonine and tryptophane, respectively).

For the majority of the amino acids present market demands are relatively small, being limited chiefly to the restricted quantities used for nutritional and pharmaceutical research and as ingredients of media employed in certain specialized types of microbiological procedures and processes. Glutamic acid is doubtless far ahead of all other amino acids from the standpoint of tonnage production. Approximately seven million pounds are now produced annually and sold in the form of the monosodium salt, which is becoming more and more extensively used as a flavor intensifier in food and in food processing.

Several of the amino acids are believed to have definite potentialities as therapeutic agents for the alleviation of specific diseases and symptoms, and much research is currently being directed toward these and related objectives. Two examples which may be cited are glutamic acid and methionine. Glutamic acid appears to function very prominently in brain metabolism and its administration has been found significantly to improve the intelligence quotient of some types of mentally retarded children. Methionine therapy has been reported to give pronounced relief to patients suffering from certain forms of liver damage.

It seems doubtful that individual amino acids, as such, or mixtures thereof will ever be used to any important extent for food supplementation in the correction of nutritional deficiencies, other than in cases where pathological or other abnormal situations are encountered. Under conditions of non-restricted food supplies a normal, healthy individual can always insure an adequate quantity and variety of amino acids in his diet by an intelligent selection of foods. ●

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Mundelein College Workshop

The science faculty of Mundelein College, Chicago, will sponsor a Secondary School Science Teachers' Workshop, June 18-22. Two lectures each morning will be offered by the College faculty in each of three fields: biology, chemistry and physics. The afternoon will be devoted to seminars conducted by secondary school teachers of science. The program of lectures to be offered was determined by questionnaire sent to all Chicago area Catholic school science teachers as well as those in the Congregation of the Sisters of Charity of the Blessed Virgin Mary teaching in all parts of the United States, for whom the workshop was planned. Sister Mary Martinette, B.V.M., is chairman.

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Book Review

(Continued from Page 61)

biographical facts much more complete than is found in the usual biographical reference books. The story covers a period extending from the late 1870's to the beginning of World War II.

There are many amusing anecdotes, and numerous details of his early home life and boyhood on a farm. He pictures college life (Case, Cornell) at the turn of the century, and tells much about his colleagues and the researches he conducted during his more than forty years at the National Bureau of Standards. Most of his studies were concerned with thermal radiation and its measurement, and some of his findings have found large practical application. In describing his work he indicates how a researcher thinks and works and mentions some of the joys and frustrations of the worker.

Surprisingly, an agnostic, he expresses keen interest in psychic phenomena and mediums. He quotes Hans Zinsser, "At times the dead are closer to us than the living." *H. C. M.*

★ ★ ★ ★ ★

Edison Institutes

Initiation of a series of Thomas Alva Edison Foundation Institutes for Science Teachers was announced on April 6 by Vice Admiral Harold G. Bowen, USN (Ret.), Executive Director of the Thomas Alva Edison Foundation, located in the Laboratory of Thomas A. Edison in West Orange, New Jersey.

The Institutes, sponsored by the Edison Foundation with the cooperation of the U. S. Office of Education, the National Science Teachers Association of the National Education Association and the American Association for the Advancement of Science, have been enthusiastically endorsed by Commissioner of Education Earl J. McGrath, President Ralph W. Lefler (NSTA), Executive Secretary Willard E. Givens (NEA), and Administrative Secretary Howard A. Meyerhoff (AAAS).

Emphasis of the Institutes will be on bringing to light the best practices for encouraging native inquisitiveness, effective methods for developing pupils' powers of careful observation, techniques for implementing creative experimentation, and skills for bringing about fruitful reading. In announcing the Institutes, Admiral Bowen said: "With the belief that the teacher is one of the keystones in inspiring young people to help themselves and that drive and the will to work will automatically provide an individual with a solid basis for accomplishment and happiness, the Thomas Alva Edison Foundation has obtained the counsel of leaders in education and industry in initiating this series of science teacher institutes for provocative discussion of vital problems."

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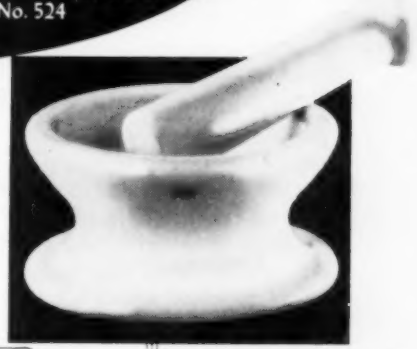

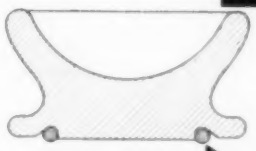

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Criminalistics

(Continued from Page 54)

Another indication of public indifference has been the lack of an effective training program for crime laboratory technicians. Obviously, education for this profession requires the resources of the university, since in-service training can be conducted only on a limited scale. The universities, however, have not, in most cases, been responsive to this need. East of Chicago there is no school where scientific criminology is taught at the graduate level. Northwestern University and the University of California are among the few institutions that offer courses in this subject. Subsidized research in this branch of science is practically nonexistent. The absence of organized research is, perhaps, the basic reason for the paucity of publications and the persistence of outmoded procedures. Police Laboratory workers must accomplish their research in time rescued from beneath heavy case loads. The stimulus for research and training which should normally have been expected from the universities and from private endowment has been conspicuously absent.

The hope for scientific criminology lies in the steady addition to its ranks of trained university graduates. Science students must be made aware of the existence of this vocational opportunity. To accomplish this the teachers of science in colleges and secondary schools should familiarize themselves with the scope and aims of criminalistics. As a means of arousing the students' interest in the social applications of chemistry and physics, this branch of science is unrivaled in its wealth of illustrative material. The spectrum table which accompanies this article is representative of the innumerable examples which are available to the instructor in physics.

The chemist will be particularly attracted by the many interesting facets of forensic work. In addition to the routine, but often difficult, problems of chemical analysis of unknown clue materials, there is the issue which is at the heart of criminalistics: When are we justified in stating that two samples have a common origin? This problem arises wherever associative evidence is in question; i.e., when it is necessary to "place the defendant at the scene of the crime." The "placing" may be done in a variety of ways. The suspect, let us say, has been found several blocks away from the scene of a safe burglary. He is searched for clues. Paint particles from his screwdriver must be analyzed and compared with the paint taken from the jimmied door; glass fragments in the suspect's trouser cuff may have fallen from the broken office door; the white substance on his shoes may be material which is used for safe lining.

These analyses at first appear to be standard chemical procedures until we reflect on the fact that the forensic chemist is interested not so much in the essential constituents of the paint, for example, as in the trace elements which creep into a particular sample of paint to distinguish it from all other samples. The impurities are of more importance to the analyst than the standard constituents. It is on the basis of these odd traces and impurities that the forensic chemist must base an opinion of the common origin of the samples. If we consider the varieties of clue materials upon which the chemist must give a judgment of this nature, it becomes apparent that he must combine a wide experience with considerable analytical ability to competently discharge his duties.

This unique aspect of police chemistry guides the selection of methods and instruments which are to be employed in the analysis. Since the available evidence sample is usually quite limited, micromethods are in constant use. Optical methods, such as crystallography, refractive index measurements, polarimetry and spectroscopy are naturally favored because of their great precision and their nondestructive nature. The spectrograph has enjoyed wide popularity in legal chemistry because of its extreme sensitivity, the small sample size and the provision of a photographic record which lends a degree of objectivity to the court testimony of the expert. In its new quarters, which it has occupied since the spring of this year, the New York Police Laboratory will have an infrared and ultraviolet spectrophotometer, an x-ray diffraction unit and an electron microscope.

The range of instrumentation which is employed to attack this basic problem of criminalistics suggests the wide areas of research that are open to the enterprising student. As an applied science, criminalistics draws on the fields of chemistry, physics, biology and other sciences for its techniques. Police scientists must maintain a constant scrutiny of the literature for methods which are developed in these sciences but which are adaptable to the purposes of criminalistics. For example, a paper describing the industrial application of x-rays to the measurement of the thickness of grease films has given rise to research in the use of x-ray excited photoelectrons as a means of photographically restoring erased ink writing.

From this brief glimpse into the workings of scientific criminology it should be apparent that the achievements of the police laboratories in this country have been by no means inconsiderable. The future of the police laboratories, however, will depend on their success in attracting competent and enthusiastic recruits. Scientific criminal investigation is rapidly approaching the level of development at which it can be said to offer career opportunities to college graduates. It should be added here that the young scientist wishing to fashion a career in criminalistics must be prepared to cope with certain minor hardships that will normally be found in a profession but lately risen from the pioneering stage. The pay which he may expect will, of course, be considerably less than that of the industrial scientist. The intrinsic interest of the field, however, together with the variety of problems and opportunities for research can more than compensate for this disadvantage. There is, finally, the satisfaction that must naturally attend his membership in a profession dedicated to the suppression of crime and the protection of the innocent. ●

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